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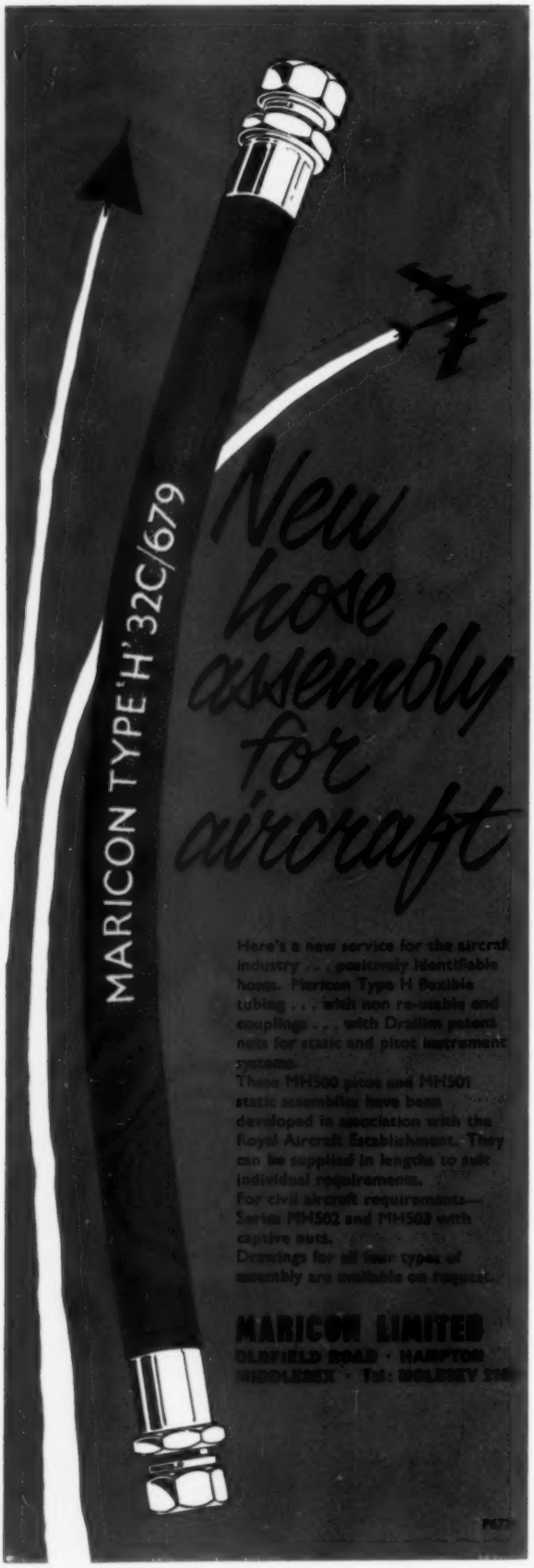
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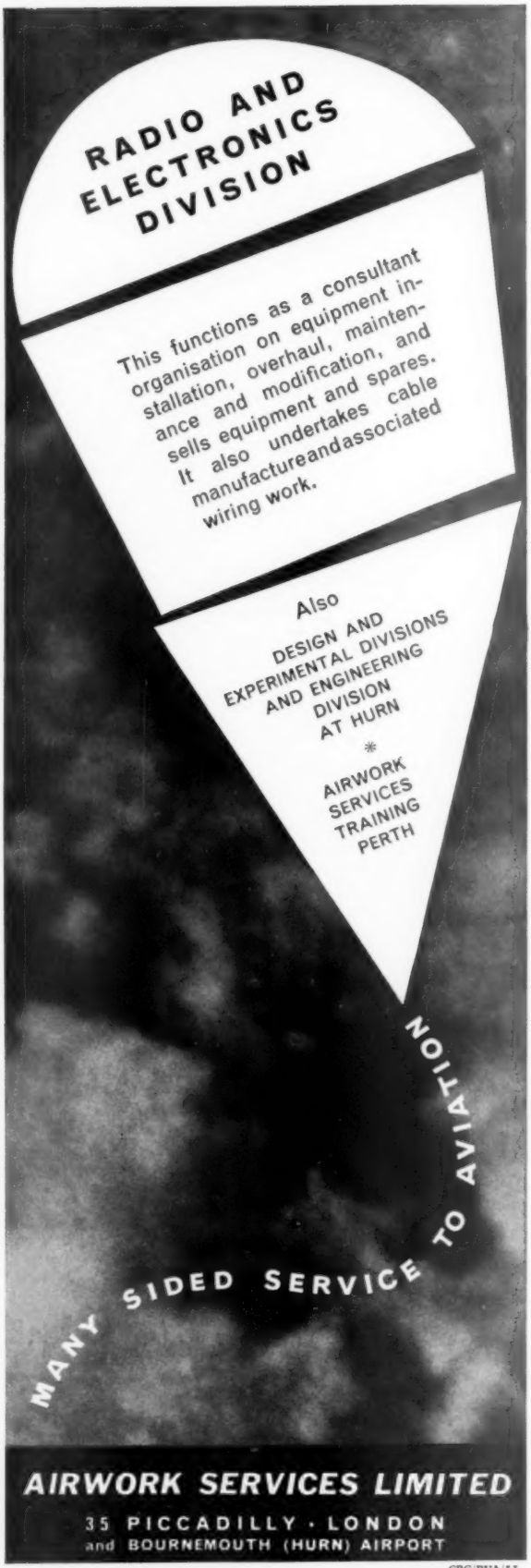
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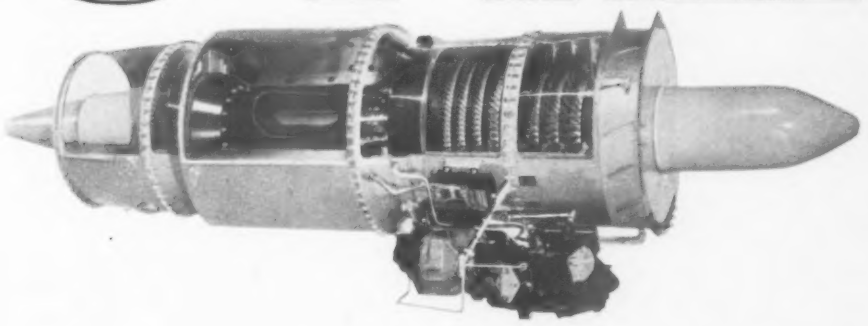

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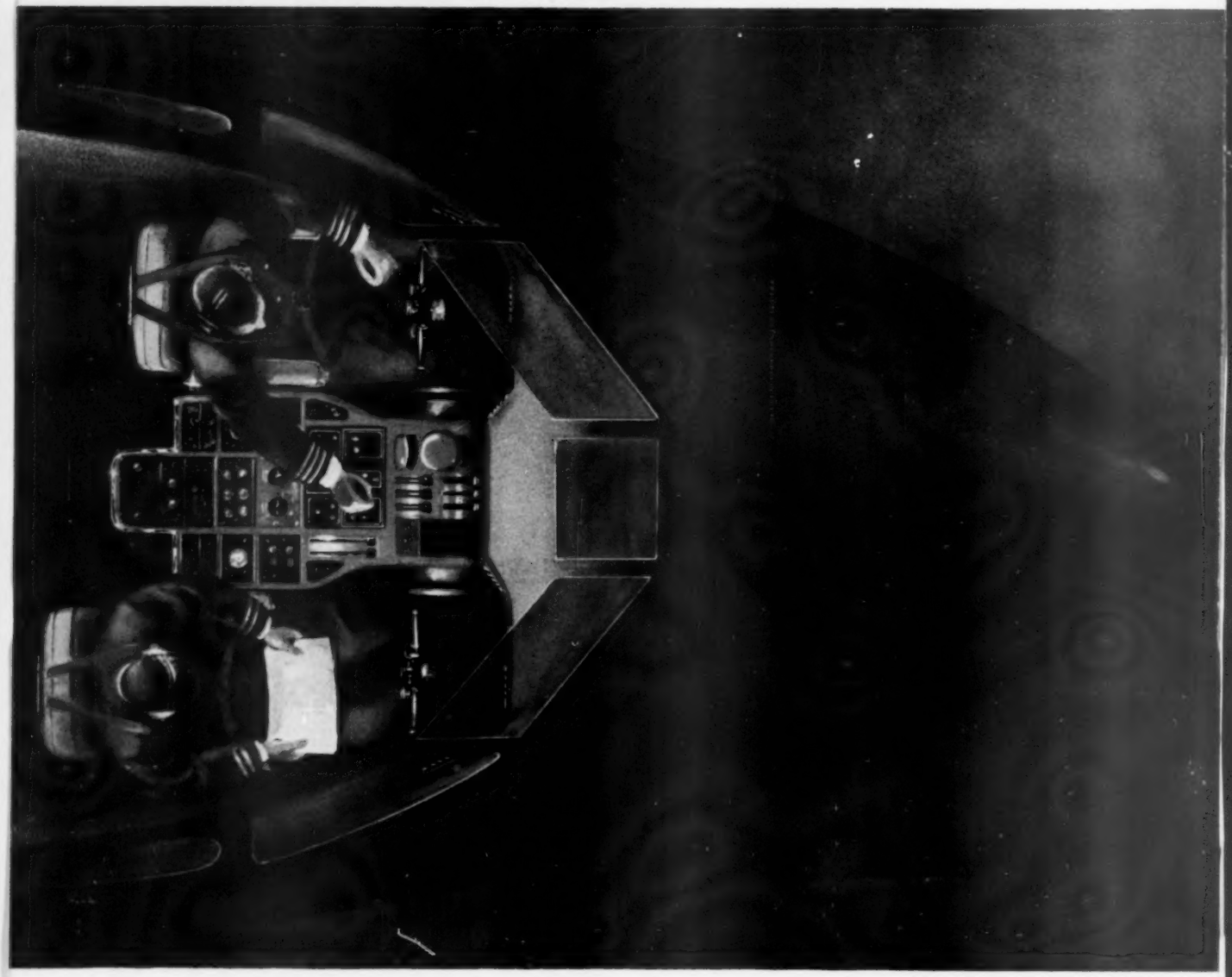

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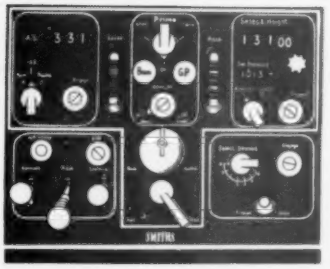

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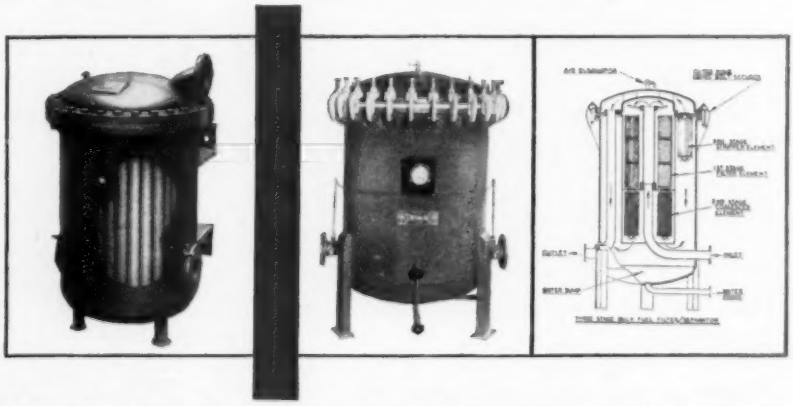

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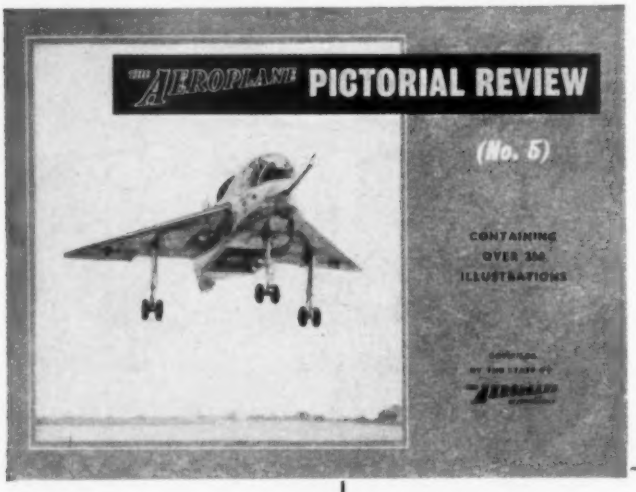

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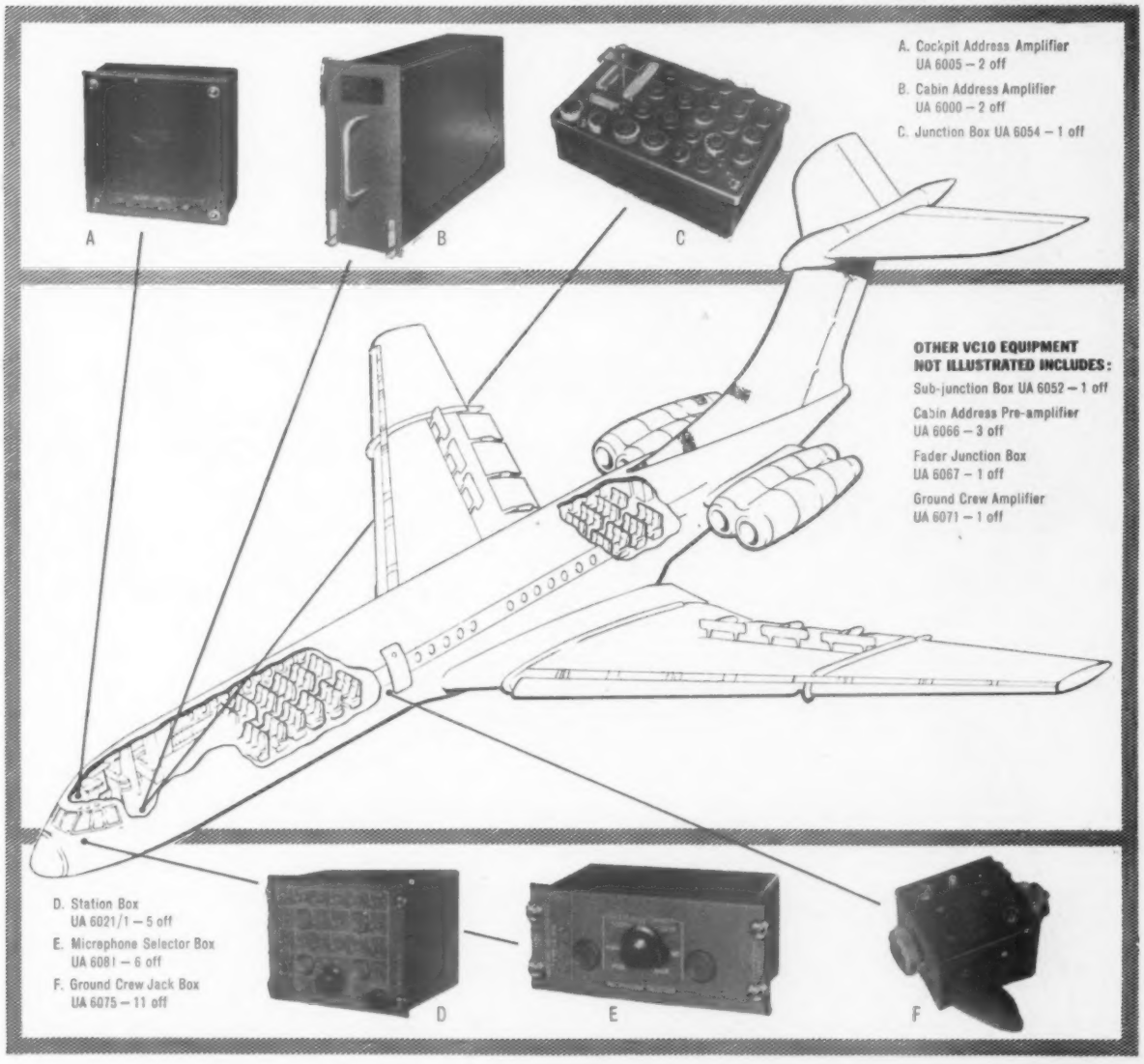
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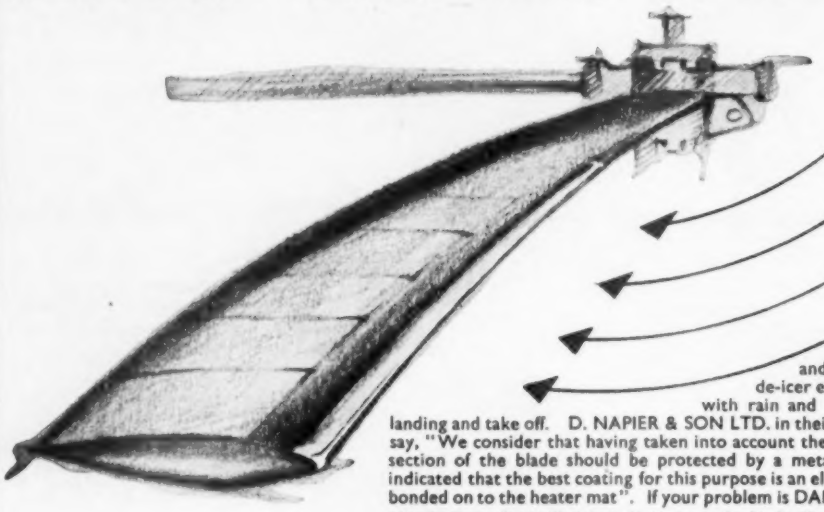

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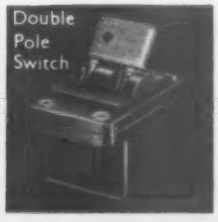

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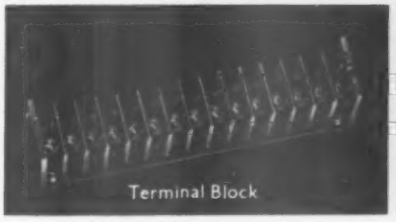

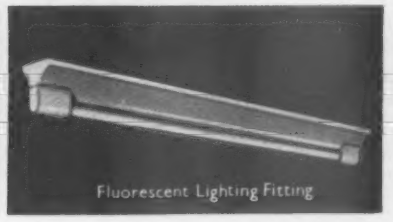

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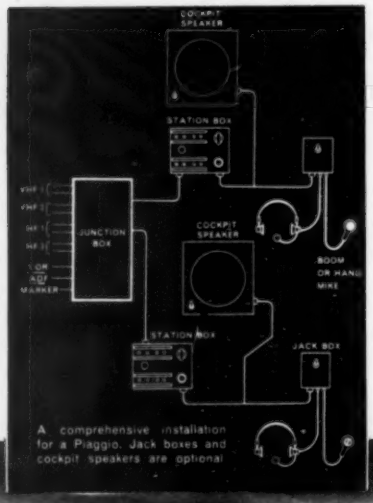

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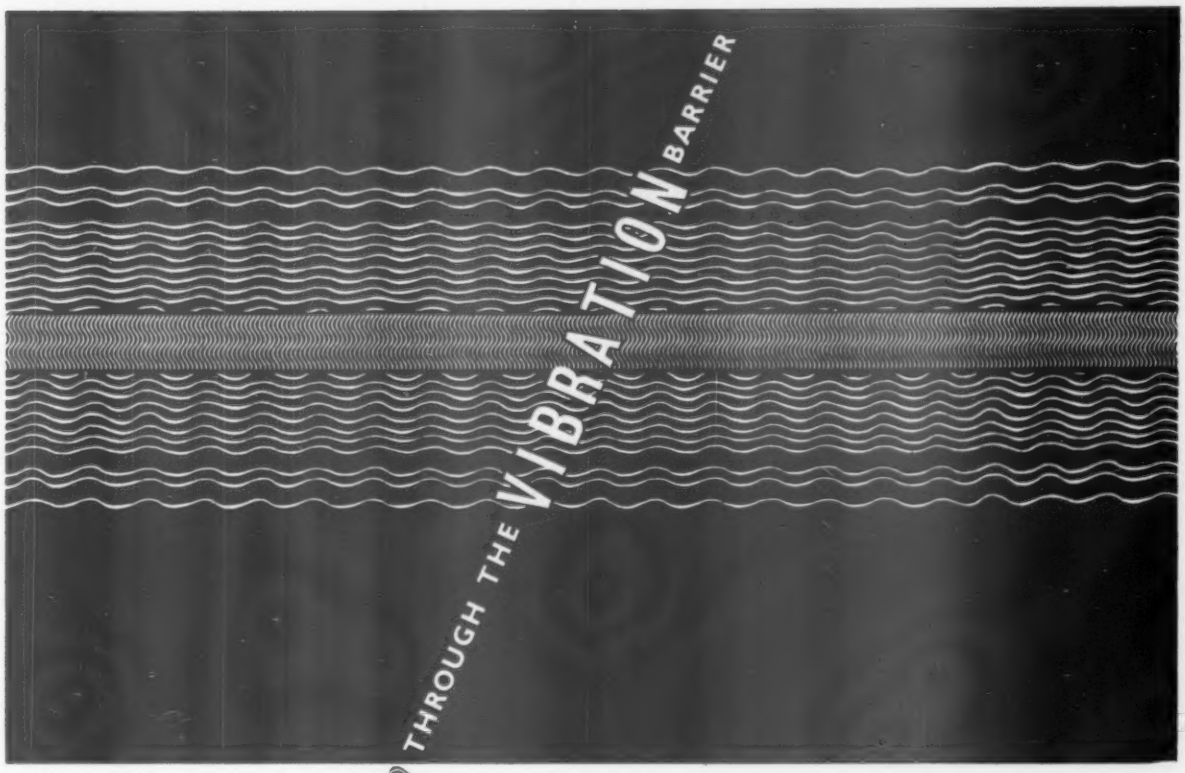

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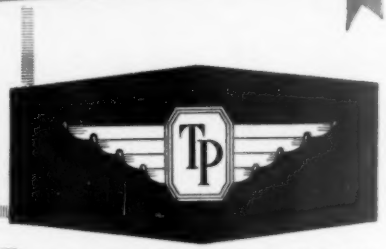

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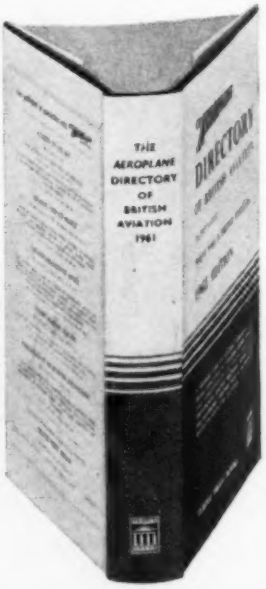

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THE AEROPLANE and ASTRONAUTICS

VOLUME 101 NUMBER 2596 JULY 20, 1961

Vital Developments

Every year, round about this time, we devote some of our space to dealing more fully with developments in the specialized field of aero-electronics. This, of course, is a subject so vast that to attempt to review all its many ramifications in one issue would be to do it less than justice. Once again, therefore, we have chosen to concentrate on one particular aspect—the all-important one of the control of air traffic, on the ground at the terminal airports, in the crowded airspace in their vicinity, and en route to its destinations.

In this particular area, the electronics industry has already played, and will continue to play, a vital part in the development of what has come to be a specialist technique in its own right. It is, moreover, a contribution without which much technological progress in the aero-dynamic and structural aspects of airframe and powerplant design would be of little consequence. Unless the proper means of controlling operational movement are made readily available, safety and regularity—two of the vital life factors of air transport—become, to all intents and purposes, non-existent.

In the special section of this issue devoted to this aspect of aero-electronics, a number of articles, written by authorities in their various fields, present some of the major A.T.C. problems and the solutions to them provided by the electronics industry. Such a review certainly shows how much progress is, in fact, being made in this direction.

What is needed most, of course, is the maximum amount of "operational research" in these matters. A specialist institution to embrace this particular facet of technological development has already been proposed. It could certainly find much with which to occupy its attention when it comes to the all-important development of the new air traffic control techniques, for without them there will be no real progress in civil—or for that matter—military aviation.

Reflections on a Visit

Quite apart from any political overtones—and they have not been particularly muted—the visit to the United Kingdom last week of the World's first acknowledged astronaut has been an event to remember. When the echoes of all the tumult and the shouting—to say nothing of a modicum of hysteria—have finally died away, Major Gagarin's welcome in London and Manchester will be remembered for what it was—a warm and sincere tribute to a man of great courage who played a leading rôle in the most remarkable pioneering achievement of modern times.

From time to time, such welcomes—and they are by no means the prerogative of this country—are accorded to the bold and the brave and the men of great achievement. And this recent reception has quite rightly been just such an occasion.

But rarely has an event of this kind been founded on so few hard facts. That is not to cast any aspersions or doubts on Major Gagarin's historical effort or on the contribution Vostok has made to astro-nautical—and aeronautical—progress in Russia. Nevertheless, on all previous great occasions of this sort, the facts of the achievement concerned have been made available in all their minutiae. In contrast, man's first essay into space is surrounded by a forest of question marks.

As we record elsewhere in this issue, even at the huge Press con-ference organized for Major Gagarin at Earls Court, not one of these question marks was removed. It seems a pity that so fine an attainment is overcast by a seemingly pointless security.

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Matters of Moment

Later Marks of Lightning

SINCE going to press with our previous issue, which featured a cutaway drawing and descriptive article on the English Electric Lightning F.1A, the first production Mark 2 version of the interceptor has flown from the company's airfield at Samlesbury. Only one further F.1A remains to be completed for the R.A.F. and Lightning F.2s and F.3s, together with the T.4 two-seat trainer, now make up the production line.

These later operational marks have been described by the Secretary of State for Air, Mr. Julian Amery, as having "better performance in range, speed and altitude, more advanced electronic equipment and an improved air-to-air weapon." Basically similar to the Lightning F.1A, the first of these two developments—the F.2—presumably has initial changes and improvements over the earlier mark while the F.3 will incorporate all of the developments at present envisaged.

To provide the better operational performance mentioned by the Secretary of State, it may well be that these later marks will be equipped with Rolls-Royce R.B.146 Avon 300-series powerplants rated at 13,220 lb. dry, or about 18,000 lb. with full reheat, in place of the two Avon RA.24R turbojets used in the Lightning F.1. Other obvious changes could include the incorporation of the OR.946 integrated flight instrument system; a new and improved internal weapons system to make use of the Red Top air-to-air missile; and provision for the carrying of additional external stores.

To date, about nine Lightning T.4s have been produced and Service acceptance trials of the trainer are now nearing completion at Boscombe Down. When these are completed it is understood that each Fighter Command Lightning squadron will receive one or more for dual checks, instrument ratings, armament demonstrations and other pilot conversion exercises.

Lord Caldecote, the managing director of English Electric Aviation, has stated that the price for the Lightning is "£450,000 upwards," depending upon the type of weapons system and other refinements incorporated.

Joining the Beagle Board

LAST week's principal news from the British executive aviation community was the announcement that Mr. P. W. Brooks, B.Sc.(Eng.), A.C.G.I., A.F.R.Ae.S.—at present fleet planning manager for B.E.A.—had been appointed to the board of British Executive and General Aviation, Ltd., as deputy managing director of the group. The official statement disclosing this said that he would take up his new duties as soon as his present commitments with B.E.A. could be concluded.

To his new post, Mr. Brooks takes a wealth of experience in civil aviation and—as a power and sailplane pilot of no mean skill—a great enthusiasm for the business of flying for fun. He will also renew a close-working association that he had with Beagle's managing director, Mr. Peter Masefield, when he was B.E.A.'s chief executive.

Born in 1920, Mr. Brooks was educated in Switzerland and received his engineering training at the City and Guilds (Engineering) College, London University. During 1940 and 1941 he was for a time on the editorial staff of THE AEROPLANE before joining the Fleet Air Arm in which he served as a pilot.

After the War, in 1947, Mr. Brooks became a technical officer at the Ministry of Civil Aviation and three years later was appointed assistant to the chief executive of British European Airways. In 1955 he became technical assistant to the Corporation's chairman, and fleet planning manager in 1960.

AT THE AIR MINISTRY.—A reception for Major Gagarin was held by the Air Council during his visit last week. Here he is with the Secretary of State for Air, Mr. Julian Amery (centre), the C.A.S. Air Chief Marshal Sir Thomas Pike (extreme right) and the Russian Ambassador Mr. A. A. Soldatov (left), on the Air Ministry Roof.

Blackbushe Reopening

AIR VICE-MARSHAL D. C. T. BENNETT has taken over a substantial part of Blackbushe airfield, Camberley, for development as a private, business and club flying centre. Blackbushe was closed by M.o.A. last year after post-War operation as a commercial airport, and most of its ground facilities, including hangars and buildings, were removed.

The runways are still in good condition, however, with 1,500 yd. of the main strip being available, together with 1,200 yd. of the N.W. run. Planning permission is being sought for 18 lock-up type accommodation, together with some light aircraft hangars.

A meeting is to be held on Thursday, Jly. 27 at 20.00 hrs. at the Hawley Hotel, Camberley, to discuss the formation of a local flying club at Blackbushe.

THE HARD WAY.—For a Service assessment of the Handley Page Herald in a military rôle, take-off and landing tests have recently been made in simulated battlefield conditions. A special 2,000-yd. "dust-bowl and mud-bath" strip was created for this purpose at Martlesham Heath. These tests have been accomplished successfully at full load and, at times, in 17-knot crosswind conditions.

Airship News in the U.S.A.

THE U.S. Navy announced on Jne. 26 that it is to give up using airships, except for two ships which are to be retained for at least another year. These will be operated by the Airship Test and Development Department at Lakehurst through the fiscal year ending on Jne. 30, 1962. The naval authorities reported, however, that when these two ships are deflated, there will be 15 Goodyear-built airships stored and available for mobilization.

Economy is the reason given for all this. Yet airships have proved to be cheaper to operate than conventional aircraft and can fly when all other aircraft are grounded. It will be remembered, too, that the R.A.F. asked for airships in 1945 to deal with the Schnorkel U-boats. The writer was at the conference which decided on this—and well remembers how the R.A.F. officers admitted that aeroplanes were too fast to deal with these new submarines.

Although helicopters can now keep station with slow-moving convoys and carry out searches at low speeds, this does not mean economy of fuel consumption. And the helicopter with its cramped and noisy quarters—with a duration limited to, say, five hours—seems a poor substitute for the airship with its roomy, quiet, vibrationless car, and its ability to remain in the air for twice as many days as the helicopter's hours!

—VENTRY.

The Second Mercury

A SECOND launching of a manned Mercury capsule on a sub-orbital trajectory was planned to take place last Tuesday at Cape Canaveral, with Captain Virgil Grissom, U.S.A.F., at the controls. At the time of going to press, however, the launch had had to be postponed because of bad weather in the range area.

As in the case of Cdr. Shepard's flight in "Freedom 7" on May 5, the booster was to be a Redstone. Whereas the first mission took the astronaut to a height of 115 miles and 302 miles downrange, a new launch angle was expected to result in a flight trajectory approximately one mile higher and three miles shorter.

The capsule itself, nicknamed "Liberty Bell," was similar to the first manned spacecraft except that it embodied a number of modifications which have been worked into the programme over the past 12 months, mainly on the advice of the astronauts themselves. It weighs about two tons at lift-off; on previous occasions, NASA has always quoted the weight of the Mercury capsule as "about one-ton," though it is known that the 16-ft escape tower accounts for an extra 900 lb. or so.

Crisis in R.A.F. Recruiting?

THE serious R.A.F. aircrew recruiting situation, the theme of almost every speech that I've heard Air Officers make in the past two years or so, was bluntly summed up by the Chief of the Air Staff, Air Chief Marshal Sir Thomas Pike, when he spoke at the Central Flying School Association's dinner on Jly. 14.

If the present trend wasn't checked and improved, he said, there would be difficulty in finding crews for all our new aircraft. At present, far too many aircrew applicants were not making the grade and, while standards must be maintained, the present wastage must be eliminated. The processes of selection and training were being urgently examined and changes were being made.

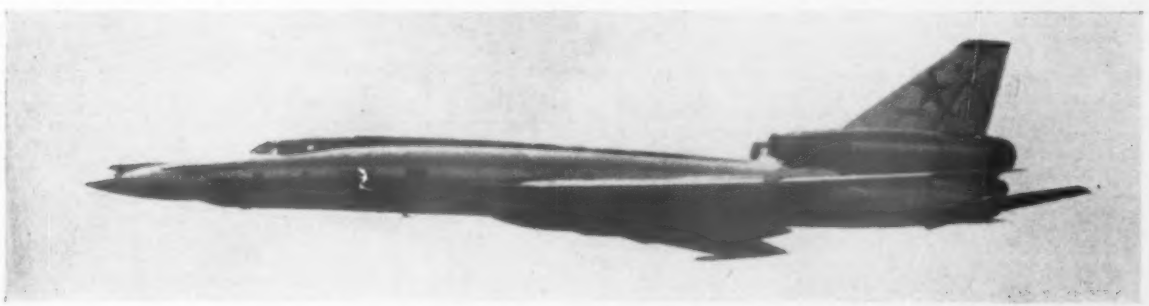
It seemed clear, for instance, that aircrew trainees must be given air experience at an earlier stage than had been the practice and, with that and other factors in mind, Initial Training Schools were being given a new look. All who were concerned with training should ask themselves: "What am *I* doing wrong? Is the trainee being discouraged?" At flying training establishments the searching question should be: "Is flying intensity high enough?"

Turning to the problem of the U.K.'s populated air space, Sir Thomas spoke of a forthcoming new Air Traffic Control organization based on Service requirements and including the automatic control of fighters. Later, it would be integrated with the control of civil aircraft.

Another aspect of civil flying was brought up by Air Cdre. H. P. Connolly, the C.F.S. Commandant, who pointed out that there was no organization for checking the piloting standards of the fast-growing numbers of pilots of private and executive aircraft. A paper on the subject was being prepared by C.F.S., whose experience, he suggested, might play a part in such an organization.

Finally, Air Cdre. Connolly hoped that when C.F.S. celebrated, next year, its Golden Jubilee it would be unchanged from what it had always been—the military bedrock on which British military aviation was built.—WREN.

DIRECT HITTER.—At the first public demonstration last week of a firing of an English Electric Thunderbird surface-to-air weapon it scored a direct hit on a Meteor target drone flying at 30,000 ft. Thunderbirds are now in service with the Guided Weapons Regiment, Royal Artillery.



BEAUTY ON THE WING.—Now code-named "Beauty," this supersonic bomber is one of the new Russian types which appeared at the Moscow air display on Jly. 9. Described as slightly larger than the Convair B-58, the Beauty has rear-mounted engines, wing trailing-edge pods for undercarriage stowage, retractable fuelling probe in the nose and a radar-operated tail turret. Ten examples appeared in the display. More pictures from Tushino are on page 67.

OPtional Reading—3

THERE was a time about 1957 when the industry as a whole thought that the noise problem was largely academic. It is true that some of the very large manufacturers were carrying out their development on suppressors; but they were still quoting costs per capacity ton-mile on the basis of performance without suppressors, and it was on these figures that many an airline ordered its jet equipment. I mention this not because I propose to write about noise but because it seems to me that there may be another factor, economically of about the same magnitude, which sections of the industry may be ignoring, but which in the end will assert itself: this is the question of crew fatigue, with special reference to jet operations.

Now straight away someone will say: "This fellow is about to plunge into the manufacture of featherbeds for pilots; domestic furnishings are not my line." Well, he had better skip the column this week; that is why it is called "OPtional Reading." But my guess is that he will be looking for it in about a year's time, when the results of one or two medical surveys and pilot strikes begin to exert their influence.

Crew fatigue was not a great problem so long as day flying predominated—say, till 1947. There were two reasons for this. Firstly, the job of commercial piloting, while not exactly a 9 to 5 routine, was for the most part 6 to 5 and enabled the crew to sleep at its accustomed hours. Secondly, the passengers normally stayed with the aircraft and the crew for the duration of the flight: so the working day for the crew was limited to what the average passenger was prepared to stand. The great increase in the capital cost of airliners, however, changed all this: it postulated a high utilization and, therefore, a high proportion of night flying and the introduction of the crew slip. This is where the fatigue problem first showed itself seriously. What was the minimum time for slipping after a 17-hr. flight from London to New York? There was little or no medical research to guide the operator in deciding on a one day or a two-day minimum slip. But that was not his only worry: he had routes not operated on a daily basis (e.g., London to Sydney) and here social considerations added to the complexity: how long could one reasonably keep a crew cooling its heels in Karachi or Darwin while awaiting the next service? And so, having no barometer for fatigue or social acceptability, the operator arranged his rosters on a trial and error basis, making no clear distinction as to whether the length of a rest period was determined by medical (safety) or social considerations.

In the circumstances of the time he showed himself very wise since for the past decade no one has succeeded in drawing a clear line between the two. But now it has to be done. The pilots of B.E.A. have said that on airways flying (and that is most of it these days) safety is prejudiced by operating a four-sector day on a Comet; they have said it with such force that they were prepared to back it up with strike action; B.E.A. has recognized the seriousness of the situation at least to the extent of requesting the Royal Aircraft Establishment Flying Personnel Research Committee to report on the subject.

As a matter of fact, B.E.A. is not the only agency to take this type of action. In 1959 the F.A.A., acting on the complaint of the F.E.I.A., set up a committee to study the medical aspects of fatigue in flight engineers flying jet aircraft. The report should have been made available in April, 1960, but all I recall at that date is a note to the effect that the committee had reached the conclusion that the problem affected all operating personnel and that it requested its terms of reference to be extended to cover pilots. One hopes that this diversion will not mean the end of the study, because to end the study will not mean to end the problem. If the governmental authorities do not get down to an unbiased scientific appraisal of crew fatigue, then the crews' own organizations will do so. In fact, the French crews' organization, SOGESTA, has already sent a medical team to and fro across the Atlantic, recording pathological, clinical and functional variations of the operating crews and of themselves. The results should be available shortly.

Pending results of these various investigations, some may continue to think that the matter is a pure chimera: or an excuse for less work for the same pay. As I mentioned earlier, in 1957 some operators shut their eyes to the noise problem and hoped it would go away. But it did not, and discounting it upset their plans pretty drastically. Before they convince themselves, therefore, that there is no genuine crew fatigue problem in connection with present operations, I would remind them that there is now a good deal of evidence that there is.

One factor taken as reliable in industry at large is that, when fatigue is serious, the petty sickness rates of workers tend to go up. Airline operators have not, so far as I know, published their statistics on this, but it is known that B.O.A.C. met the problem when it first introduced the Comet; T.A.A. met it with the Viscount; P.A.A. and Air France with the 707. In all these cases the initial approach was that there was no reason why a pilot who was used to flying a monthly quota of 85 or 90 hr. on piston-engined equipment could not continue to do so on the turbines. They tried it. But in all cases they had to cut back: where scheduling difficulties did not impose a limitation (as in short-haul work it tends to do), the increase in petty sickness imposed its own limitation.

The cut-back seems to have settled to a figure of about 70 hr. This has, however, been arrived at by a variety of methods. In the case of B.O.A.C. and T.A.A. it is believed that company medical opinion had a strong influence and the cut was, at least to some extent, voluntary on their part. In the case of P.A.A. the reductions have been brought about mainly by processes somewhat idiomatic to the United States, namely the various contractual "pay and credit" formulae (e.g., for each two hours on duty in the air *or on the ground* one hour will count towards flight time and, incidentally to our subject, towards flight pay). In the case of Air France the pilots went on strike.

The above are not isolated cases. The problem applies to nearly all airlines or it will soon apply. It would, therefore, be only prudent to take into account the facts of life when planning the utilization of jet crews.—C.C.J.

Cranfield's Day

AT the College of Aeronautics on Jly. 7, the annual presentation of diplomas, prizes and awards was made by Mr. Alan Bullock, Master of St. Catherine's College, Oxford.

SIR FREDERICK HANDLEY PAGE, chairman of the Board of Governors, referred, in his opening remarks, to the increasing importance of the College as a national centre of post-graduate training, with new courses in such subjects as automobile engineering, welding technology and operational research.

Presenting the prizes, MR. ALAN BULLOCK spoke of the comparative youth of the College. It was obvious, he said, that during the 14 years of its existence, it had established itself and made an important niche for itself by satisfying a need for a particular type of education.

Speaking as a historian, he emphasized that technology was not a new development but was in fact the oldest of the crafts. The effects which technology had made on the development of civilizations were profound, and he regretted that technologists did not set their sights high enough. It was insufficient that technologists should make inventions which could change the method of living for millions of people, and then expect to pass on to other people the sociological problems which these changes brought about. Technologists must realize the implications of what they did, and apply their experience and training in such ways as to ensure that their work was for the general benefit of mankind.

Mr. Bullock doubted the wisdom of forming departments of technology at existing universities, where the idea was that, by contact with students in other faculties, some culture would rub off onto the technologists. Society is an amalgam of all subjects, and he believed that the better way would be to create technological universities such as Massachusetts Institute of Technology, where—from within their own realization of the need—the technologists would very soon create schools in economics, politics, sociology, history and the arts.

Back to Bristols

FROM the Bristol Aeroplane Co., Ltd., comes an announcement that Mr. C. J. Luby, M.I.Prod.E., A.F.R.Ae.S., has joined its board. He has been joint managing director of Dowty Rotol, Ltd.—a position from which he recently resigned—since 1960.

Mr. Luby is no newcomer to Bristol Aeroplane Company affairs, for he served his apprenticeship in what was then the company's Engine Division, and in 1942 was works manager of its experimental department. Prior to that, however, in 1937 he had been appointed works manager of Rotol Airscrews, Ltd. (later to become Rotol, Ltd.).

In 1951 Mr. Luby went to Canada as president of Canadian Steel Improvement, Ltd.; and in 1956 he was invited to join the board of Rotol, Ltd., as assistant managing director. Two years later he was appointed managing director to succeed Sir John Evetts, who had become chairman. And when the Rotol company was acquired by the Dowty Group Mr. Luby was appointed joint managing director of the new subsidiary—Dowty Rotol—formed to integrate the Group's aircraft equipment interests.

The 1961 Air Race Finals

Above, King's Cup first, second and third: Brian Iles, Wg. Cdr. McIntosh and Teddy Knox (right to left).

LAST week-end's air meeting at Coventry for the King's Cup race and the Lockheed Aerobatic championship was visited by the full fury of the English summer. While torrential rain did its best to turn the grass areas of Baginton into a quagmire, proceedings were livened on Friday afternoon by a freak whirlwind which rolled the judges' caravan for the Lockheed contest on to its side, judges and all, in an additional and unscheduled aerobatic manœuvre.

Apart from this unexpected evolution, the meeting was notable for the introduction of two startling new aerobatics by the Czechs, whose national champion Jiri Blaha gained a thoroughly well-deserved victory in the Lockheed International competition. The King's Cup was as closely contested, Sqn. Ldr. Brian Iles—twice previously British Air Racing Champion—maintaining a short lead from Wg. Cdr. McIntosh past the finishing pylon. And on the basis of the Coventry and Cardiff race meetings, master-butcher Sid Aarons became the 1961 British Air Racing Champion.

In some respects, however, the weather was less unkind than it might have been. After day-long delay on Friday, when pilots and visitors were treated to a remarkable succession of meteorological phenomena, conditions finally improved sufficiently towards late evening for the finals of the Lockheed Trophy event to be held. On Saturday, despite the odd shower, Baginton avoided the worst of the day's thunderstorms farther afield, and the King's Cup race took place in light winds and good visibility under a heavily overcast sky.

Far left, flanking the winner of the 1961 Lockheed International Aerobatic championship, Jiri Blaha, of Czechoslovakia, are left, Verette of France (second) and Trebaticky, also a Czech, third.

Left, winner of the S.B.A.C. Trophy for the fastest speed in the King's Cup, Viv Bellamy is seen here in the cockpit of his Spitfire 8, with Tiger Moth pilot J. W. C. Judge.

Photographs copyright "The Aeroplane and Astronautics"

The Lockheed Trophy

From the preliminaries of the Lockheed event, on Thursday, seven pilots (two having tied) were selected from the 17 entrants for the final contest. As usual, none of the British contestants qualified, despite excellent performances by the Tiger Club pilots. Charles Boddington's demonstration was particularly impressive, but it is quite clear that the Tiger Moth, even with an inverted fuel system, cannot compete against more specialized aircraft. Norman Jones recently bought a Stampe for the Tiger Club, however, and next year British pilots should stand a very good chance in the Lockheed International event.

On the other hand, there can be no argument that the Zlin Z.226 has established itself as the supreme aerobatic aircraft throughout the World. The three Czech pilots who came over with this type flew it far beyond the limits normally established for light aircraft, and apart from proving its amazing strength, showed the perfection of each individual control at any point in the speed range, and the excellence of the inverted fuel and oil pick-up.

It was unfortunate that the Russians did not appear at Coventry; in the Yak-18 they have a good aerobatic aircraft, and a single-seat version appeared last year at the Bratislava championships. There was apparently some prospect this year of the well-known test pilot Kokkinaki bringing over the new Yak-32 light jet trainer to Coventry but, according to Russian officials, his visit was cancelled at the last minute. His participation would presumably have been connected with the Soviet exhibition.

Blaha, who is a test pilot in Czechoslovakia, flew a programme of smooth continuity and superb assurance, in a single-seat Zlin Z.226 Akrobat. Two of these were brought over by the Czech contingent, by whom they had this year been fitted with spats over the fixed undercarriage to minimize reduction of speed during high-*g* manœuvres. Power margin and acceleration are as important as precise control, particularly in many inverted aerobatics, so that aerodynamic cleanliness

Below, a Victor from the Gaydon O.C.U. flies over the parked racing aircraft. Left, the unique and venerable Arrow Active belied its years in the hands of Dennis Hartas.

KING'S CUP AIR RACE, 1961

Race No.	Pilot	Aircraft	H'cap.	Start order	Lap 1	Lap 2	Lap 3	Finish	Speed, m.p.h.
3	C. P. Francis ..	Turbulent ..	00.00	1	1	1	3	—	—
18	N. H. Jones ..	Tiger Moth ..	02.18	2	2	2	1	16	106
28	P. B. R. Vanneck ..	Tiger Moth ..	02.29	3	3	3	2	14	107
52	Miss S. Scott ..	Jackaroo ..	02.48	4	4	5	5	18	106.5
21	J. W. C. Judge ..	Tiger Moth ..	02.50	5	5	6	6	19	106.5
16	G. Rees	Tiger Moth ..	03.32	6	6	4	4	9	110.5
5	C. Gregory ..	Taylorcraft "D" ..	04.39	7	7	7	7	13	113.5
14	I. Trethewey ..	Tiger Moth ..	06.10	8	8	9	9	15	118
22	C. E. Elton ..	Tiger Moth ..	06.35	9	9	8	8	7	121
41	R. Crowhurst ..	Comper Swift ..	09.44	10	10	11	14	20	129
35	H. B. Iles ..	Miles M.18 ..	11.12	11	11	10	10	1	142
43	S. M. Aarons ..	Hawk Trainer ..	11.27	12	12	12	12	6	141
48	D. Hartas ..	Arrow Active ..	11.40	13	13	13	13	5	142.5
91	R. H. McIntosh ..	Cessna 175 ..	12.05	14	14	14	11	2	145.5
19	P. G. Masefield ..	D.H. Chipmunk ..	12.25	15	15	15	15	12	144.5
63	G. P. Watson ..	Proctor 3 ..	14.37	16	16	17	17	17	155.5
72	T. Knox	Proctor 3 ..	14.56	17	17	16	16	3	161
80	P. Blamire ..	Gemini 3 ..	17.11	18	18	18	18	8	174
94	G. Marler ..	Falcon 6	17.26	19	19	19	19	11	176
96	R. R. Paine ..	Hawk Speed 6 ..	19.25	20	20	20	20	10	191
99	V. H. Bellamy ..	Spitfire 8 ..	26.50	21	21	21	21	4	298

becomes important. This seems to be the weakness of the biplane in advanced aerobatics.

The new international champion also exhibited to perfection the new manœuvre, which, unfortunately, from the observer's point of view, defies description. The Czechs call the variations of this manœuvre "Lomcovak No. 1" and "Lomcovak No. 2," but as there is no precise translation for this term, beyond "flicking very quickly," this does not take us very far. It is not a flick roll, although the aircraft is stalled, and the nearest one can get to describing it is to say that it is a horizontal rotation of the aircraft, which has its vertical axis in the line of flight and the cockpit facing in the same direction.

It can be entered from a vertical bank, at which point the stick is pushed hard forward, and as the aircraft turns through 90 degrees, still on one wing, full top rudder is applied to start the rotation. Up to three complete turns can be performed, with the aircraft cartwheeling forwards and downwards, and from the ground, appearing to travel backwards at times, before recovery. The second variation appears to be from the top of a loop, when it seems to do the same thing while going vertically upwards.

Originality is a rare commodity in any activity, but it is especially rewarding in aerobatics. Coupled with the precise control in all the classic manœuvres performed by Blaha, it left very little argument in selecting the winner. Blaha's demonstration is the ultimate mastery of man over aeronautical machine; he puts the Zlin at any attitude and any point in the sky with absolute precision, relative to the ground, his positioning being faultless.

Freed of height restrictions during a repeat performance in the air display programme, he held the Zlin down within an inch or so of the ground after take-off at full throttle, suddenly rearing up and snapping over into a half-roll, for a steep inverted climb-away. He started an outside loop from about 50 ft., and also demonstrated the rarely seen *Messerfliegen*, or "knife-flying," in a vertical side-slip, at a similar altitude. His programme also included a tail-slide into an inverted spin, inverted stall-turn, vertical aileron turn upwards and downwards, two upward flick rolls, a flickering eight-point half-roll and a stall-turn into a very tight outside turn.

Verette, from France, did extremely well in coming second in the face of Czech competition, pitting his Stampe S.V.4 biplane against the Zlin monoplanes. He finished his rapid succession of erect and inverted manœuvres towards the lower height limit of 100 m., which is good positioning if carefully done. Third man home, Trebaticky, was the only Czech flying a two-seat Zlin Z.226; he did everything Blaha had done, but without so much finesse.

Liardon, from Switzerland, who was fourth in a Bücker Jungmeister, seemed to give very little away compared with his competitors, and final placings must have been very difficult to decide. Fifth was J. d'Orgeix, from France, in a Stampe, followed by the third Czech, Hulka, in a Zlin Akrobat, and Charollais in another Stampe.

The King's Cup

Twenty-one aircraft lined up on Saturday afternoon at the 24 end of Baginton's 5,300-ft. runway (eventually to be 11,000 ft.), for the start of the air race of the year. One entrant, 73-year-old J. M. Donald, was a non-starter, probably because weather prevented him arriving from Scotland, while there was one substitution, Norman Jones standing in for Basil Maile. No startling modifications were apparent among the assembled types since their last appearance in the London-Cardiff events, and if one or two of the engines had been "breathed on," the work was duly reported on the handicap forms.

It seems from the close finish to the race that pilots have to get up very early indeed to beat handicappers Joe Lyons, C. M. Britland and W. J. Charnley. One or two also discovered this on the starting line, when unobtrusive (and undeclared) bits of Sellotape over the odd aperture were detected and removed by the eagle-eyed officials.

To Clive Francis went the distinction of leading off in the 1961 King's Cup, in the roundel-marked Tiger Club Turbulent which he uses to visit public schools, in his duties as an R.A.F. liaison officer. Off went the little red Turbulent round the scatterpoint on top of the Alvis test sheds, for the first of the four laps of the 17-18-mile course. Behind him, at rapid intervals, after a two-minute delay, followed a clutch of Tiger Moths and Sheila Scott's Jackaroo which fought a private race all the way round, jockeying on the pylons.

Francis came round at the end of the first lap before Brian Iles, the eventual winner, and passenger had taken off on his 11.12 min. handicap, and half the field were still to go. Typical of the variety of competing aircraft were then the Hawk Trainer of Sid Aarons, Dennis Hartas in the veteran Arrow Active—looking very fast—Wg. Cdr. McIntosh in the Cessna 175, the only American type in the race, and Peter Masefield in his executive Chipmunk.

As one by one the back markers roared off after the field, which was streaming round on its second lap, Viv Bellamy's Spitfire sat with stationary airscrew awaiting its 26.50 start time. Ron Paine, the last but one off, in fact, completed his first lap in the very fast Speed Six before the Spitfire finally took off, trailing black smoke from its 14-lb. boost as it climbed over the contestants, to begin its task of lapping them all three times.

First position changes came as Rees emerged in front of the biplane gaggle round the airfield pylon at the end of the second lap. Significantly, Brian Iles also gained a place over the Comper Swift by the end of Lap 2, and Knox had changed places with Watson, whom he had followed at the start, in a tussle between the two Proctors. The Spitfire flashed round at the end of its second lap just as Masefield brought his Chipmunk into the third.

By then, Norman Jones had taken the lead in his Tiger Moth, with Peter Vanneck lying second and Francis third. "All-weather Mac" was doing very well in the Cessna, having gained three places, and his chances looked very promising. All but the Spitfire had then streamed round the pylon for the last lap, when the small shape of Francis' Turbulent slipped in over the A-W sheds to land with oil pressure trouble. Several minutes elapsed before the Spitfire tore round to join the rest of the field, Bellamy turning widely round the pylons within his maximum *g* capability at top speed.

When the first dots became identifiable over the trees on the home run, Iles' white M.18 was seen to have a clear lead over the Cessna, which was in hot pursuit. Mac, with passenger Malcolm Hackett, could not quite make it over wily Iles, twice previously the British Air Racing Champion, and Knox also did not quite have the legs to close from third place. Good handicapping and good flying were evidenced by the arrival of the Spitfire in fourth place, together with the best part of the field in a closely spaced finish.

To Iles, then, went the King's Cup, and to Aarons, the 1961 B.A.R.C. award. Bellamy gained a well-earned prize in the form of the S.B.A.C. Trophy for the fastest speed, averaging nearly 300 m.p.h. round the very small circuit.

The King's Cup race was the main event in a varied display programme during the Saturday afternoon, which included a number of Service items. These were opened by a Handley Page Victor from the O.C.U. at Gaydon, followed by refuelling demonstrations and fly-pasts by U.S.A.F. KB-50J, F-101C, F-100D and B-66B. Solo aerobatics by a Vampire T.11 were to an unexpectedly high standard. Formation aerobatics were performed by 92 Sqn. Hunters and C.F.S. Jet Provosts.

Welcome visitors were the Mystère IVs of the Patrouille de France, complete with tricoloured smoke, and there were also displays by a Canberra and a Chipmunk. Other Service participation included delayed drops by the S.A.S. Skydivers from two Beavers and an Auster 9 of the Army Air Corps.

On the civil side, the prototype Beagle-Auster Airedale, G-ARKE, made a welcome re-appearance at Coventry, showing its exceptional low-speed manoevrability and docility in the hands of Ranald Porteous. The Handley Page Herald also flew past, and the afternoon was completed by a circus of executive types including the Aztec, Comanche, Travel Air, Meta-Sokol, Skylark, Cessna 172 and 175.—JOHN FRICKER.

Aviation News in General

SWISS BLOODHOUNDS.—An order from Switzerland estimated at between £25-£30 million for the Bloodhound SAM system is to be placed with B.A.C. pending the approval of the Swiss Parliament. This is said to be "somewhat larger" than that from Sweden (see last week's issue).

AVONS IN AMERICA.—A British turbojet went into service with an American domestic airline for the first time when United Airlines introduced the Caravelle VIR on its New York-Chicago service on Jly. 14. Two Rolls-Royce Avon 532R turbojets power the VIR.

JAPAN'S STARFIGHTERS.—First of 180 F-104J Super Starfighters for the Japanese Air Self Defence Force has made its first flight from Lockheed's Palmdale, Calif., facility where it is to be flight-tested. Two more F-104Js are to be built by Lockheed. The remaining 177 will be produced in Japan.

TRAINERS FROM CESSNA.—Production of the Cessna T-37 has been extended into mid-1963 by U.S.A.F. contracts worth about $5 million for additional T-37Bs. These are destined for "several friendly foreign countries under the Military Assistance Program to bolster their defence and training forces." More than 600 T-37s are in use with the U.S.A.F.

CUBAN MiGS.—A Colombian newspaper has credited Cuba with 26 MiG fighters of an undisclosed type, but American sources say that the number may be greater. Some 80 Cubans are reported to be receiving pilot training in Iron Curtain countries.

ROTARY RECORD.—Latest Soviet submission to the F.A.I. for recognition as a World record is one for helicopters in the class for women. Anna Gueppennere piloting a Mil Mi-1 has averaged 118.06 m.p.h. over a 100-km. closed circuit.

TOO THIN.—Owing to a printer's error, the thickness/chord ratio of the Lightning's wing was given last week (page 43) as 0.016. No doubt English Electric's rivals in the supersonic aircraft business will be relieved to know that the correct figure is 0.06.

MORE FOR SPACE.—Elliott-Automation and C. A. Parsons and Co. have joined the British Space Development Company. Elliott-Automation will be represented on the technical committee by Mr. W. R. Thomas, joint general manager of Elliott Brothers (London), Ltd. C. A. Parsons and Co. will be represented by Dr. H. M. Finniston, deputy research director.

MOUNTAIN MOVED.—In the caption of the picture of two Hastings of No. 36 Squadron on page 17 of our Jly. 6 issue we inadvertently placed Mt. Kilimanjaro in Kenya. It is, of course, in Northern Tanganyika, near Kenya's southern border.

MORE VOSTOK QUESTIONS.—In a special B.B.C. television interview following his Press conference at Earls Court, Major Gagarin explained that he could not say whether the capsule shown at Tushino was the actual spaceship or an exact replica of Vostok. He asserted categorically that there was no other manned space flight in Russia before his.

TIROS AGAIN.—Launched by a Thor-Delta rocket from Cape Canaveral on Jly. 12, the 285-lb. "weather satellite" Tiros III was established in a near-circular orbit at about 400 miles. It differs from earlier models in having two wide-angle TV cameras. Within two hours, it was sending back pictures of a storm off the Labrador coast.

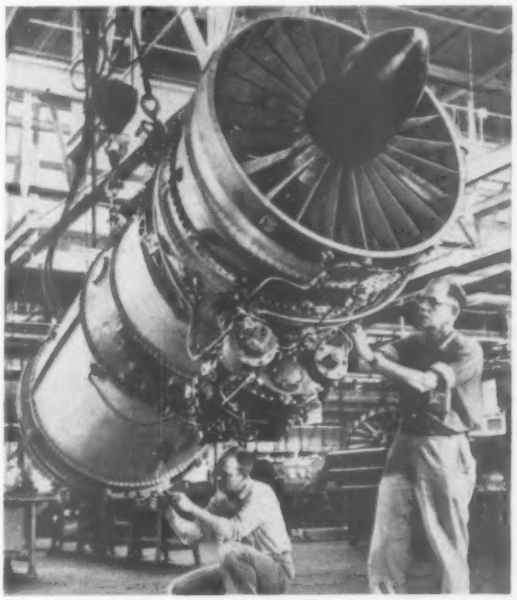
MIDAS TOUCH.—First attempt to launch a Midas infra-red missile-detection satellite into a polar orbit was made successfully from Point Arguello, Calif., on Jly. 12. The 3,500-lb., 30-ft.-long satellite—the entire top stage of the Atlas-Agena B launching vehicle—is traversing a high near-circular orbit with an apogee of about 1,850 miles.

U.A.R. ROCKETS.—The U.S. State Department announced on Jly. 7 that permission had been granted for the United Arab Republic to purchase "weather research rockets" in America.

SPACE POST.—West German Postal Authorities have reached agreement with NASA to co-operate in the joint U.S.-British-French programme of space communications using Relay and Rebound satellites.

TWO-MAN CAPSULE.—The Martin Company has a project for a two-man Mercury-type space-capsule which, they state, could be placed in orbit by 1964 using a booster derived from the Titan programme. It would be used mainly to test the reliability of spacecraft system components and sub-systems.

(Commercial Aviation Affairs are on page 66)



FIRST FAN.—More than 60 hours' test-stand time has been accumulated by the 14,000 lb.s.t. Pratt & Whitney JT8D turbo-fan, the powerplant for the Boeing 727. Flight trials will begin later this year.

News About People

ENGINEERING DIRECTOR.—Mr. J. R. Leach, chief engineer of Sir George Godfrey and Partners, Ltd., has been appointed a director. He joined the company in January, 1960, from Vickers-Armstrongs (Aircraft), Ltd., where he had been flight test manager for a number of years.

HANNS KLEMM.—Dr. Hanns Klemm, who was famous for his range of light aircraft designs, died in May at the age of 75. His beginnings in the aircraft industry were made in 1917 when he worked with both Dornier and Heinkel. His first real light sports aircraft, the Kl-20, first flew in 1923-24. His last design, the Kl-107, was produced in Germany by Bölkow.

JOINING PYE.—Formerly with Smiths Aircraft Instruments, Ltd., Wg. Cdr. T. W. T. McComb has now joined Corran Works (Pye Radio), Ltd., as director and general manager.

MR. A. S. BISHOP.—It is with regret that we record the death on Jly. 10 of Mr. A. S. Bishop, a former managing director and chairman of the Goodyear Tyre and Rubber Co. (Great Britain), Ltd.

MR. E. R. PRING.—We also regret to record that Mr. E. R. Pring, who retired from the board of E. K. Cole, Ltd., last year, died recently. He joined the company as a director in the first year of its formation 34 years ago.

Air Transport

European Fares Up . . .

AN across-the-board 5% increase in European air fares has been agreed by the IATA Traffic Conference and, subject to governmental approval, will become effective on Nov. 1 next. The new fares will apply generally on international services in the area composed of the U.K., Ireland, Scandinavia, France, the Benelux countries, Switzerland, West Germany, Austria, Italy, Yugoslavia, Algeria and Tunisia. This area excludes Spain, Portugal and Greece.

The increase is attributed by IATA to the general rise in costs in Europe. It is not expected to "affect the continuing growth of air traffic," said Mr. K. A. Kristiansen, chairman of the Traffic Conferences.

. . . and Atlantic Fares Down?

PRIVATE talks between IATA member airlines operating on the North Atlantic, on the subject of cheap fares, were continuing in London this week. A similar meeting held in New York last month was inconclusive. The talks centre round proposals to introduce cheaper excursion fares and promotional fares: figures of £107 for a 23-day London-New York excursion and £70 return per person for organized groups have been mentioned.

The progress of the talks has been influenced by the recession of traffic on the North Atlantic this year, but there are indications that the worst is now over. In May, the average load-factor on all North Atlantic services was 48% compared with 71% in May, 1960, but progressive improvements have been recorded in June and in the present month to date.

Apron Services by Airlines

AGREEMENT has been reached between the Ministry of Aviation and the Airline Representatives Board that the airlines will be responsible for the provision of apron services and airside passenger transport in the Central Terminal Area at London (Heathrow) Airport. Hitherto, the Ministry has been responsible for all airside passenger transport, and for providing apron services to the majority of airlines, including B.E.A. and their associates. This practice contrasts with that at the North Terminal, where the airlines have been responsible for these services.

The new arrangements in the Central Terminal will come into effect on Apr. 1, 1962, on which date the airlines will also take over certain internal porterage facilities provided by the Ministry. Detailed arrangements for the take-over are now being worked out.

A Hovercraft Service Planned

APPLICATION has been made by Starways, Ltd., of Liverpool, to the Air Transport Licensing Board for licences to operate cross-river services by hovercraft. The application follows a policy decision by the Government that hovercraft should be regarded, for licensing purposes, as aircraft rather than as ships.

One of the applications is to run hovercraft ferry services across the River Mersey, and the others are for similar services between either bank of the Thames and from Canvey Island; between any points on the north and south banks of the River Severn and the Bristol Channel; on the routes Liverpool-Isle of Man, Liverpool-Belfast, Liverpool-Holyhead-Dublin; and Glasgow-Stranraer-Belfast. Also planned are services on the routes Portsmouth-Southampton-Bournemouth-Isle of Wight; Southampton-the Channel Isles; Newquay-Penzance-Scilly Isles; Dover-Calais; and Harwich-Rotterdam-Antwerp.

Starways are already discussing orders for hovercraft with two manufacturers who have already produced prototypes. They plan eventually to have a fleet of 14 vehicles capable of carrying 100-150 passengers at 75 m.p.h., but 50-seaters would be used at first and might be in use in two years' time. Liverpool Airport would probably become Starway's first hovercraft maintenance base and a second one is likely to be established at Glasgow.

Two Tragedies

TWO major accidents within 24 hours marred airline operations last week. The first, and perhaps the most disquieting, occurred at Denver, Colorado, on Jly. 11 to a United Air Lines DC-8, which veered off the runway on landing, hit a lorry on a new runway under construction, and caught fire. Of the 115 passengers and seven crew, 16 passengers were killed and at least 45 were injured; the driver of the lorry was also killed. According to survivors of the accident, the captain had informed them shortly before the landing that the hydraulic system was inoperative through loss of fluid. The brakes and nosewheel steering on the DC-8 are hydraulically operated.

On Jly. 12, an Eastern Air Lines' DC-8 swung off the runway at Miami when landing after its pilot had reported "hydraulic trouble." All tyres on the main undercarriage blew out but none of the 99 passengers or eight crew was injured.

A telegram was sent to all DC-8 operators by the F.A.A. on Jly. 13 announcing changes in the procedure for emergency operation of the DC-8 hydraulic system. The purpose of the change is to conserve as much hydraulic accumulator pressure as possible during emergency lowering (by free-fall) of the landing gear. Attention was also drawn in the F.A.A. telegram to the possibility of an inadvertent opening of the DC-8 thrust reversers after the pilot had placed the controls in reverse. This could lead to loss of control of the aircraft.

C.S.A., the Czech airline, lost its second Il-18 this year on Jly. 12, when an aircraft of this type crashed nine miles south of Casablanca. All 64 passengers and crew of nine were killed. The aircraft was en route from Prague to Accra, had called at Zürich and was to land next at Rabat. The latter airfield was closed by fog, and the Il-18 was diverted to Casablanca. There, also, the airport was closed, and the aircraft was diverted to the military base at Bouskoura. It apparently flew into high-tension cables while turning away from Casablanca.

Reducing the Competition

A DISTINCT change of attitude towards airline mergers has become apparent in the U.S. Civil Aeronautics Board since Mr. Alan S. Boyd was appointed chairman by President Kennedy. Whereas the board in the past had adopted a passive attitude towards mergers, it is now actively encouraging them and is conducting its own investigations to discover which airline should merge with which.

Two airlines which are actively involved in the "merger market" at this time are Northeast—which had an operating loss of $6 million in 1960 and $800,000 in the first quarter of 1961—and Continental. Mergers of both these airlines would, it is reported, be in accordance with C.A.B.'s plans for strengthening the industry.

Northeast, it will be recalled, itself initiated merger discussions with T.W.A. more than a year ago. T.W.A.'s own problems of reorganization and re-equipment slowed the progress of this deal, which had been approved by the Northeast board, and it was formally dropped on Mar. 31 last. The C.A.B. came into the picture when Northeast applied for a renewal of its licence to operate its New York-Florida route (the existing licence expires on Nov. 27 next). This route, for which Eastern and National are also authorized, has not come up to expectations since Northeast became the third carrier on it five years ago, and for this reason among others the C.A.B. is believed to favour a merger between Eastern and Northeast. This would reduce the competition on the New York-Florida service.

Before considering the Northeast renewal application—a preliminary hearing took place on Jly. 11—the C.A.B. had ordered an investigation to be made to consider whether "the integration of the routes of Northeast and another air carrier into a unified system by merger . . . would be in the public interest." It also asked the 10 other U.S. trunk operators to

(*Continued on page 65*)

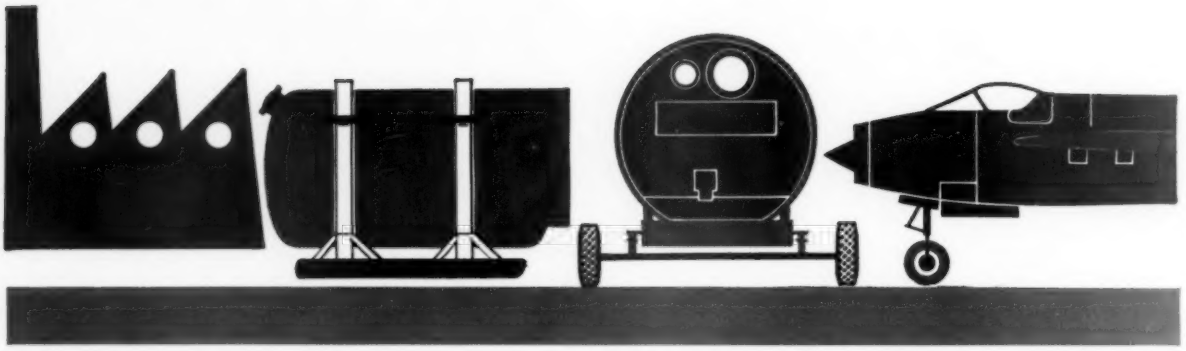
RUSSIAN ROTORCRAFT.—This model of the Mil Mi-6 helicopter at the Soviet Trade Exhibition shows a prospective airline version with 60 seats and a ventral entry door.

Photograph copyright "The Aeroplane and Astronautics"

Ten years with Aer Lingus

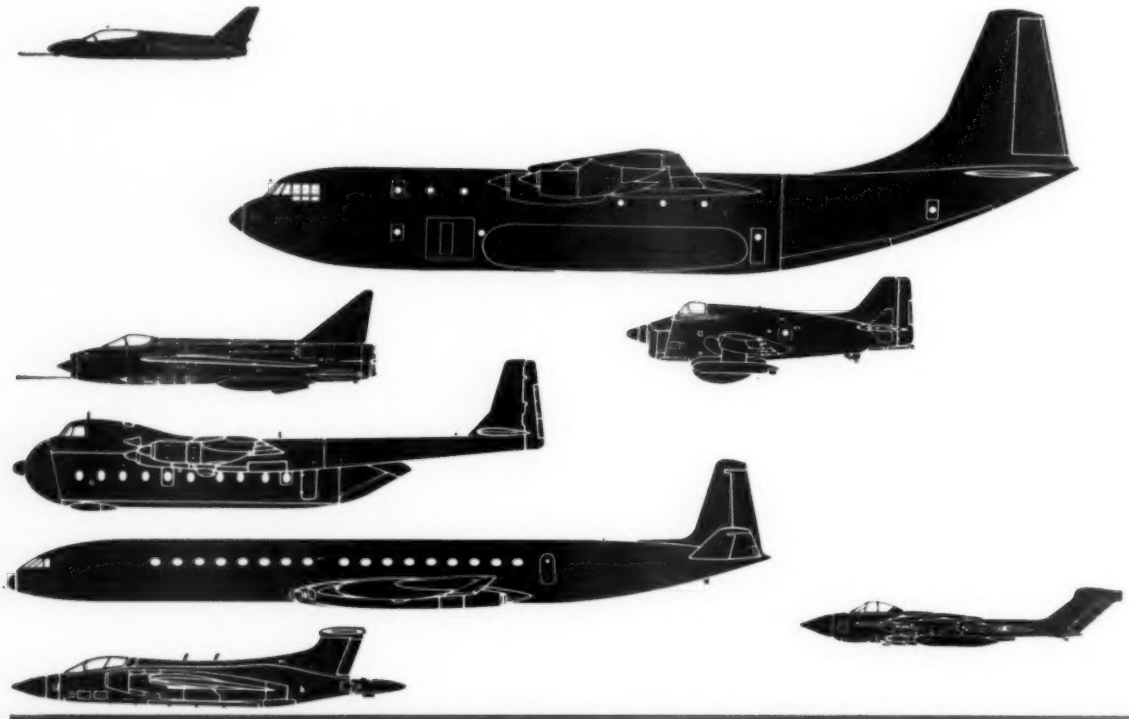
In the Lisbon circuit, a Viscount of Aer Lingus. From small beginnings twenty-five years ago the Aer Lingus network has grown to encompass thirty cities of Europe as well as transatlantic New York. AIR BP has served the Aer Lingus European network for ten years. At Lisbon AIR BP fuels seven major airlines with the speed and command of detail that comes of perfect teamwork and full understanding of the operator's needs.

Fast flying AER LINGUS... fast fuelling AIR BP



BRITISH OXYGEN

COMPLETE GROUND-TO-AIR LIQUID OXYGEN SERVICE



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Air Transport . . . .

(*Continued from page 64*)

indicate whether they would be interested in merging with Northeast.

As we noted briefly last week, Pan American has shown some interest in response to this request, but only if the New England and other local routes could be transferred to another airline. Pan American is primarily interested in obtaining a Boston-Miami route, serving other eastern U.S. cities, but has been repeatedly prevented from doing so by the C.A.B. in the past.

Riddle Airlines also has shown some interest in a merger with Northeast as a means of obtaining authority to operate a low-fare, no-frills, air-bus passenger service in the eastern U.S., of the type for which it recently applied to the C.A.B. The Board is not expected to regard this proposal favourably, as Riddle is considered primarily as a freight operator.

Whatever the outcome of these manœuvres, it now seems certain that the number of U.S. domestic operators will be reduced in the course of the next year or two, along the lines suggested by some prominent airline executives, including Mr. C. R. Smith, president of American Airlines. Reduced to its simplest terms, the problem is one of too much competition, which has led airlines to overspend on new equipment and at the same time has kept load factors down to uneconomical levels. Is there a lesson here for the Air Transport Licensing Board, whose continuing hearing into the European routes case is noted below?

Continuing the European Routes Case

DAYS eight and nine of the Air Transport Licensing Board hearings in the major European routes case were taken up with individual route applications (see our issues for Jne. 29, Jly. 6 and Jly. 13). For much of these two days, B.U.A. was the applicant and B.E.A. the objector, and a pattern of procedure was quickly established which made it possible to dispose of some eight routes a day; with the applications heard the week before, this brought to 19 the total of individual routes considered by the end of Jly. 12.

The principal witness for B.U.A. in these applications is Mr. Dennis Whybrow, appearing as commercial adviser to the company (he is also general manager of Channel Air Bridge). For each route, a set of data has been prepared by B.U.A.; as an example, that for London-Cologne is reproduced here. After Mr. Whybrow has answered questions from Mr. Gerald Gardiner, Q.C. (for B.U.A.) he is cross-examined by Mr. H. E. Marking (B.E.A. secretary). The main purpose of Mr. Marking's questioning is clearly to establish that the traffic B.U.A. would carry would not be of a new *type*, but would be holiday and business traffic of the kind already carried by B.E.A.

For each route, B.E.A. has prepared a table showing the relationship of B.U.A.'s capacity and expected traffic to the total B.E.A. traffic forecast on the route up to 1965. The B.E.A. table for London-Cologne is also reproduced here.

Following Mr. Whybrow's evidence, B.E.A. as the main objector calls Mr. W. R. Collingwood to testify to the likely effect of the B.U.A. applications, if granted. His evidence includes an estimate of the revenue loss to B.E.A. (on the assumption that B.U.A. would achieve 60% load factor in a 64-seater and *all* passengers would be diverted from B.E.A.). On London-Cologne, this loss was estimated to be £121,000 per year; the loss forecast for eight routes considered on Jly. 12 alone exceeded £1 million in total.

Mr. Collingwood also gives evidence on the bilateral agreements in existence between the U.K. and the other country concerned, to emphasize the B.E.A. claim that Britain is limited to approximately 50% of the total traffic and B.E.A. already carries this. In some cases, detailed statistics are given to show that the British share is more than half (i.e., London-Cologne, 58%; London-Düsseldorf, 59%, including B.O.A.C. and the independents). Mr. Collingwood also compares B.E.A. traffic in the first quarter of 1961 with that for 1960, showing, in some cases, an actual decline (e.g., London-Düsseldorf 3% down, London-Hamburg 5% down) and in other cases a growth rate well below forecast.

From time to time this pattern of procedure has been interrupted by a question from a member of the Board or by the appearance of another objector in the case. When the applicant was Cunard Eagle, Mr. Ashton Hill appeared in place of Mr. Whybrow, but Mr. Marking's questioning followed an identical pattern: "Are you going to generate new traffic on this route? Are you going to carry holiday traffic? Are you going to carry business traffic? What types of new traffic are you going to generate?"

The hearings were to continue on Jly. 17, 18 and 19 this week, and then on Jly. 25, 26, 28 and 31, and Aug. 1, 2, 9 and 10. At the present rate of progress, it appears that some nine more days will be needed to hear the 52 outstanding route applications (including 11 for domestic routes), and another day or two for the winding up, so the days allocated so far may just be sufficient to conclude this marathon case.

Application No.: A.1015.
Route: London (Gatwick)—Cologne.
Round-trip capacity requested by B.U.A.: 156 flights—19,968 seats.

Total passenger traffic between U.K. and Germany in 1960	Not available
Average annual increase	Not available
Total travelling by air in 1960	420,000
Average annual increase 1952–1960	23.4%
Forecast average annual increase 1960–1964	9.5%
Traffic on U.K./Cologne route in 1960	25,433
Average annual increase 1952–1956	16.9%
1956–1960	26.2%
Traffic on London/Cologne route 1960	24,454
U.K. residents visiting Germany 1954–1960	1,454,000
Average annual increase 1954–1960	18.1%
German residents visiting U.K. in 1960	167,000
Average annual increase 1954–1960	12.1%
Tourist air fare	£22 5s.
Cheapest possible air fare	£22 5s.
Cheapest surface fare (rail/boat)	£10 16s.
Estimated air traffic on U.K./Cologne route in 1965 (Based on a forecast 20% average annual increase 1961–1965)	63,280
Round-trip capacity requested by B.U.A.	19,968 seats
Percentage of total air traffic in 1965 represented by B.U.A.'s application at:	
(a) A 35% load factor	6,988 passengers=11%
(b) A 50% load factor	9,984 passengers=15.8%
(c) A 60% load factor	11,980 passengers=18.9%

These tables are examples of the information supplied by B.U.A. (above) and B.E.A. (right) in relation to each individual route application.

ROUTE LONDON—COLOGNE

	SUMMER		WINTER		ANNUAL	
	Pass.	P. miles (M)	Pass.	P. miles (M)	Pass.	P. miles (M)
1963/4						
B.E.A. traffic	14,900	4.9	6,900	2.3	21,800	7.2
B.E.A. growth	1,300	0.4	600	0.2	1,900	0.6
B.U.A. capacity (seats)	11,476	—	8,192	—	19,668	—
B.U.A. expected traffic*	6,891	2.3	4,096	1.3	10,987	3.6
B.U.A. expected traffic as % B.E.A. traffic	—	47	—	57	—	50
B.U.A. expected traffic as % B.E.A. annual growth	—	575	—	650	—	600
1964/5						
B.E.A. traffic	16,400	5.4	7,600	2.5	24,000	7.9
B.E.A. growth	1,500	0.5	700	0.2	2,200	0.7
B.U.A. capacity (seats)	11,476	—	8,192	—	19,668	—
B.U.A. expected traffic*	6,891	2.3	4,096	1.3	10,987	3.6
B.U.A. expected traffic as % B.E.A. traffic	—	43	—	52	—	46
B.U.A. expected traffic as % B.E.A. annual growth	—	460	—	650	—	514
1965/6						
B.E.A. traffic	17,900	5.9	8,300	2.8	26,200	8.7
B.E.A. growth	1,500	0.5	700	0.3	2,200	0.8
B.U.A. capacity (seats)	11,476	—	8,192	—	19,668	—
B.U.A. expected traffic*	6,891	2.3	4,096	1.3	10,987	3.6
B.U.A. expected traffic as % B.E.A. traffic	—	39	—	46	—	41
B.U.A. expected traffic as % B.E.A. annual growth	—	460	—	433	—	450
1962/3 to 1965/6						
B.E.A. growth (cumulative)	4,300	1.4	2,000	0.7	6,300	2.1
B.U.A. expected traffic*	20,673	6.9	12,288	3.9	32,961	10.8
B.U.A. expected traffic as % B.E.A. accumulated growth	—	493	—	557	—	514

*Based on 64-seater aircraft at 60% Passenger Load Factor (67% summer and 50% winter).

Air Transport . . . .

Fairchild F-27s Continue

A BATCH of eight advanced-model F-27s is being built by Fairchild at Hagerstown on speculation, following a new survey of the potential market. The first of these aircraft is scheduled to fly in September with the remainder to be completed by the middle of 1962. Production of the F-27 was stopped by Fairchild early in 1960, with five production aircraft and a demonstrator available for immediate sale. After more than a year during which no F-27s were sold, interest in the aircraft was renewed by a sales campaign late in 1960, and all six F-27s have been sold this year.

Two new variants have now been developed by Fairchild and the eight new aircraft will incorporate several features to improve performance. In particular, the rear fuselage has been improved by replacing the two large airscoops for the air conditioning system by a flush inlet on the fin leading edge. A 15-knot gain in cruising speed is claimed for this "clean-up."

A version known as the F-27F is now undergoing F.A.A. certification for a gross weight of 39,400 lb. (compared with 38,500 lb. at present) and a landing weight of 37,500 lb. This is expected to be available for executive operators by October and the aircraft now being built will be of this type. A second stage in the development of this version will raise the gross weight to 42,000 lb. and a fuel jettisoning system will be introduced. At the higher gross weight, the F-27F will carry a 7,250 lb. payload (36 passengers) a distance of 1,600 naut. miles.

A second new version is designated F-27G, and is a freighter with 42,000 lb. gross weight. Various fuel capacities are offered in this version, the maximum range with 2,090 U.S. gallons being 2,560 naut. miles with a 5,000 lb. payload.

Fairchild are still actively promoting military and naval versions of the F-27 as a DC-3 replacement.

Loftleidir in 1960

SOME interesting facts about the operations of the non-IATA carrier Icelandic Airlines were given recently at the company's annual meeting. The company—Loftleidir H/F—operates only on the North Atlantic route between Europe and the U.S., by way of Iceland. During 1960 a total of 350 round-trips was flown, plus two extra flights between Iceland and Europe. The number of passengers carried increased from 35,498 to 40,773, giving a load factor of 65.3%; these passengers represented about 2% of the total on the North Atlantic.

Two DC-6Bs were put into service on Apr. 1, 1960, and one of the two DC-4s was sold to Interocean Airways of Luxembourg after being withdrawn from service on Jly. 1. The other DC-4 operated throughout the year together with a second of the same type leased from Braathen's SAFE. On Mar. 4 this year a third DC-6B was purchased (from Pan American) for $630,000. The second DC-4 has now been sold. A fourth DC-6B will be purchased later this year.

The company operated in 1960 with a permanent staff of approximately 270, additional staff being taken on during the summer. Flying crews (which are now all Icelandic) comprise 17 captains, 22 co-pilots, nine navigator/radio operators, 15 engineers and 45 stewardesses.

Revenue during the year amounted to I.Kr. 227 million (approx. £2.1 million) and the net profit was I.Kr. 1.14 million (£10,600).

Commercial Aviation Affairs

BRITANNIAS FOR SALE. — The latest edition of the *Market Report* published by Aircraft Exchange includes an offer to sell two Britannia 302s at the end of this year for $2,100,000 each. This version of the Britannia is operated by Aeronaves.

BAHAMAS VISCOUNT.—Following the re-acquisition of Bahamas Airways by B.O.A.C., an ex-B.W.I.A. Viscount 702 has been converted (by Scottish Aviation, Ltd.) to a 52-seat four-abreast layout and is now in service on the Nassau-Miami route in Bahamas Airways livery.

TOURIST ATTRACTION. — Finnair has introduced a night tourist flight from Helsinki to the northernmost tip of Europe, North Cape, which is made wholly in sunlight and returns to Helsinki early the following morning.

S.A.A. BOEINGS.—Configuration of South African Airways Boeing 707s has been changed from 93/32 to 111/20 economy and first-class seats to meet the growing demand for cheaper travel on routes to Europe.

WEATHER SHIPS IN 1960. — An ICAO report on the activities of the nine North Atlantic weather ships during 1960 shows that they made 12% more routine radio contacts with aircraft than in the previous year. Aircraft flying across the Atlantic received 47,732 radar fixes, 44,623 non-scheduled radio beacon transmissions and 2,901 DF bearings. Three people were rescued from the sea including the crew of two from a non-scheduled U.S. transport carrying a cargo of explosives, which ditched alongside one of the ships last September.

AVRO SAFE FLIGHT.—Safe Flight precision stall warning systems have been ordered by A. V. Roe for use in the Avro 748 transport.

SOUTH AFRICAN NEWCOMER.—The first major non-scheduled airline to obtain a licence in South Africa for nine years will begin operations in August. Operating as Terra Grande, it will fly amphibians from Johannesburg to the Seychelles Islands and to out-of-the-way fishing areas on the east and west coasts of South Africa.

A.R.B. NOTICE.—Details of the procedure for obtaining a certificate of airworthiness for export, which is necessary in future for all new or used aircraft which have been built in the U.K., are given in Notice No. 61 issued on Jly. 1 by the Air Registration Board.

LEEDS/BRADFORD RESULT. — In the year ended Mar. 31 the Leeds/Bradford Municipal Airport had an operational income of £38,855, exceeding operational expenditure by £1,002. Additional expenditure on extensions and improvement totalled £21,876, and this is being borne by the two corporations.

NEW AIRPORTS.—A private landing ground two miles from the centre of Hyderabad is to be developed as a municipal airport capable of handling DC-3s and Fokker F-27s. A new airport for jet operation is to be built at Kurmitola to serve Dacca, in place of the present airport at Tejgaon which is considered to be too near the city centre. A 10,500-ft. runway will be completed at Kurmitola by 1964.

APPEAL DROPPED.—Falcon Airways, Ltd., decided not to proceed with its appeal against a decision by the Director of Aviation Safety on its application for an air operator's certificate. The hearing arranged for Jly. 12 was cancelled.

B.E.A. APPOINTMENTS.—With effect from Aug. 1 the following four appointments have been made by B.E.A. in the Eastern Mediterranean area: Mr. H. P. Lambe to be deputy manager, Greece and eastern Mediterranean; Mr. K. Nathan to be manager, Israel; Mr. M. S. Brander, to be manager, Levant (based in Beirut) and Mr. R. R. Martin, to be manager, the Gulf (based in Bahrain).

TV AT SOUTHEND. — In order to serve a busy intersection at Southend Airport which is not visible from the control tower a Marconi closed circuit television channel has been installed.

TRANSPAC AGREEMENT. — An agreement between IATA and the Trans-Pacific Passenger Conference will make it easier for passengers between North America and the Orient or Australasia to fly one way and go by ship the other. Members of the two organizations can now become parties to a standard agreement without separate negotiations.

JAP JET.—The first of five Convair 880-Ms ordered by Japan Air Lines has been christened "Sakura" (Cherry Blossom) and was delivered to the airline at San Diego earlier this month.

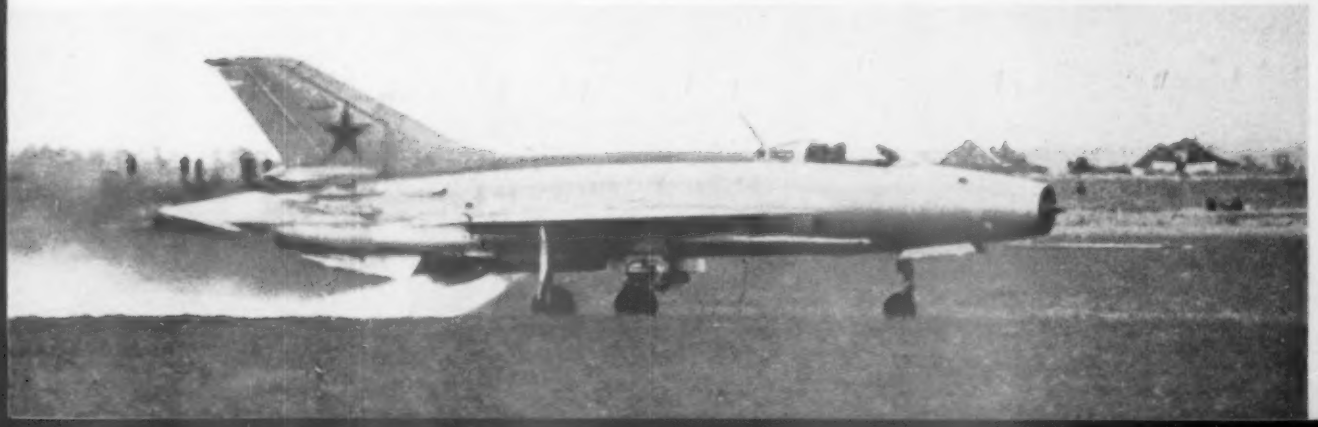
More Russian Revelations

Above, two new photographs of the supersonic aircraft code-named "Bounder," a single example of which appeared in the Tushino display. The delta wing appears to be about the same size as that of the Avro Vulcan; the engines are believed to be 28,660 lb. s.t. D-15 turbojets.

Left, a modified Tu-16 ("Badger") with a large nose radome for target acquisition and a primitive-looking powered bomb under the belly.

Left, a new picture of the Yak-25 version known as "Flashlight-C," which is probably a tactical light bomber.

Below, a revealing photograph of the delta-winged Sukhoi "Fishbed" making a rocket-assisted take-off from the grass at Tushino. Features to note are the intake centre-body, which is believed to be movable, the small intake by the wing root, and stowage for the tail parachute.



The Fighting Services

Air Rank Appointments

GROUP CAPTAIN A. FODEN, C.B.E., Command Signals Officer, R.A.F. Germany, has been appointed to the post of Director of Telecommunications, Air Ministry; and Gp. Capt. L. H. Greenman, now commanding No. 30 Maintenance Unit, Sealand, is to become Senior Technical Staff Officer, H.Q., Far East Air Force, Singapore. Both will assume the rank of Air Commodore in their new appointments at the end of next week.

Having joined the R.A.F. in July, 1939, Gp. Capt. Foden has been a signals specialist throughout his career. He has been Command Signals Officer, R.A.F. Germany, since last September.

Gp. Capt. Greenman joined the R.A.F. as an airman in 1936, and was a sergeant-pilot before being commissioned in 1940. He has been a Technical Branch specialist since 1942. Between 1940 and 1944 he served with the Ministry of Aircraft Production and in the U.S.A. on engineering duties.

Marine Helicopter Pilots

UNDER a new scheme to provide the Royal Marine Commandos with a proportion of their own aircrew, officers of the Corps are now specializing as helicopter pilots. This means that the Royal Marines will select officers to fly some of the helicopters in the Commando carriers H.M.S. "Bulwark" and H.M.S. "Albion," who will replace a number of the Royal Naval pilots engaged in this task.

Selected officers will have 12 months' flying training followed by two years in a Commando helicopter squadron. This will be followed by two years' regimental duties and a further two years with a Commando squadron before returning to general Royal Marine service.

The first helicopter pilot of the Corps is Lieut. R. Learoyd, a former National Serviceman who was called up in 1955. He served overseas with 3rd Commando Brigade, Royal Marines, as a temporary 2nd lieutenant and was selected in 1957 for a permanent commission. He served overseas with 40 Commando, Royal Marines, between 1958 and last year, when he was selected to undergo training as a helicopter pilot. He will join H.M.S. "Bulwark" as a member of No. 848 Squadron next month.

SHAPE Appointment

NEXT January Air Commodore C. B. E. Burt-Andrews, C.B.E., is to become United Kingdom National Military Representative at SHAPE.

Appointed Secretary-General of Allied Air Forces Central Europe in 1951, he later became head of the Far East Defence Secretariat in Singapore. Since October, 1958, Air Cdre. Burt-Andrews has been the first Commandant of the Pakistan Air Force Staff College in Karachi.

Twenty-one Years of Parachuting

LAST week the R.A.F. No. 1 School of Parachute Training at Abingdon celebrated 21 years of existence. Established in 1940 as the Central Landing Establishment, the School has trained more than 120,000 British Army and other parachutists and logged over 750,000 descents from at least 18 different types of aircraft.

During the Second World War the School, then located at Ringway Airport, Manchester, spread its sphere of influence until parachute training schools were operated in India, the Middle East and Italy. Since 1945 it has met requirements in Egypt, Palestine, Cyprus, Germany and the Far East.

At the end of the War the School moved to Upper Heyford, where it operated for some years. In 1950 it moved again, to Abingdon, and it has been there that most of the significant developments have taken place. Double-door jumping was introduced in 1951, and the kit bag, Bren gun and rifle valises were replaced by the weapons container.

Today the School, commanded by Wg. Cdr. B. F. Stannard, A.F.C., has expanded its syllabus from basic parachute training for the British Army to include courses for parachute medical teams, air dispatchers, Sandhurst and Cranwell cadets and Special Air Services free-fall trainees, as well as men from other nations. It has a total of 30 officer and 107 warrant officer and N.C.O. instructors, all members of the Physical Fitness Branch.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Bomber Command: Wg. Cdr. D. C. Williams to R.A.F. Marham as senior technical officer; Sqn. Ldr. D. J. Leith to R.A.F. Feltwell for instructional duties, with acting rank of Wg. Cdr.

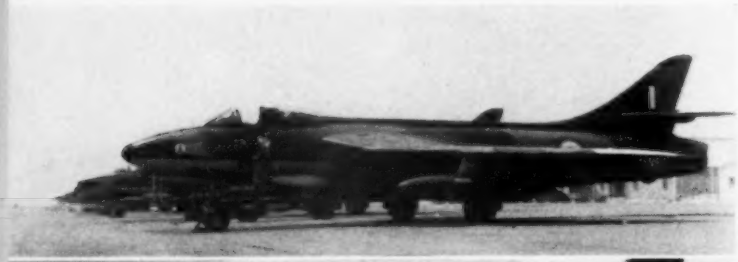
Fighter Command: Wg. Cdr. W. J. Swift to R.A.F. Manston to command.

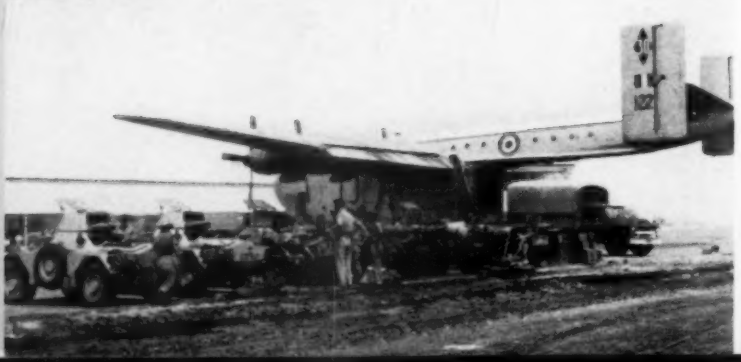
Coastal Command: Wg. Cdr. L. G. A. Reed, M.V.O., D.F.C., to Headquarters for air staff duties.

Flying Training Command: Wg. Cdr. T. H. Blackham, D.F.C., to R.A.F. Linton-on-Ouse as Chief Instructor; Wg. Cdr. L. G. Martin to the R.A.F. Staff College, Bracknell, for directing staff duties; Sqn. Ldr. C. B. Elford to R.A.F. Biggin Hill as President of the Board of the Ground Officers Selection Centre, with acting rank of Wg. Cdr.

Technical Training Command: Sqn. Ldr. K. C. D. Nixon, A.F.C., to R.A.F. Bircham Newton for instructional staff duties, with acting rank of Wg. Cdr.

Maintenance Command: Wg. Cdr. J. A. D. Sturges to No. 14 Maintenance Unit, Carlisle, to command, with acting rank of Gp. Capt.





KUWAIT ACTIVITIES.—During the recent Kuwait operations Hunter FGA.9s of No. 208 Sqn. from Nairobi (top), with those of No. 8 Sqn. from Khormaksar, flew in on Jly. 1 ahead of the first British troops. One of these squadrons has since been withdrawn. Centre, men of the 2nd Battalion, the Parachute Regiment, deplane from a Britannia C.1 which flew them in from Cyprus. Bottom, heavy equipment flown in by Beverleys of Nos. 30 and 84 Sqns., Middle East Command.

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AERO-ELECTRONICS

ON the following thirteen pages some of the present and future developments in Air Traffic Control systems and the problems of long-haul navigation are studied. A table sets out the operational features and functional uses of the leading types of ground and airborne electronic equipment for navigation, Air Traffic Control and communications purposes.

The present international position on long-range navigation equipment and the absence of a "standard" aid are dealt with in the opening article. This describes the navigational procedures in various areas of the World and the possible long-range ground-based aids which are likely to be investigated at the seventh meeting of the COM Division of ICAO in Montreal early next year. Vertical separation problems in air traffic systems and associated procedures are also discussed in this article.

From the extensive field of civil radar data handling systems at international terminals the installations at Zurich and Geneva have been selected for detailed description in this aero-electronics supplement. At both of these airports, the display systems provide a means of co-ordinating radar data for control purposes from three separate radars designed to fulfil different operational rôles.

In the last two articles in this survey, research and development in Air Traffic Control techniques in the United Kingdom are covered. The first deals with the experimental computer system to be installed at the Oceanic Control Centre at Prestwick in August and the second describes the computing system under development for the Ministry of Aviation's Air Traffic Control Experimental Unit at Heathrow.

These two activities represent important experimental programmes which are likely to have a considerable influence on the overall improvement of Air Traffic Control procedures generally. Certainly, the equipment described will make a valuable contribution towards the necessary extension of existing knowledge in a complex technology which has come to be one of paramount importance.

Aero-Electronics . . . .

The Problems of Long-haul Navigation

By H. E. Smith *

AGAINST a background of extensive international operations (from the latest visual glide-path indicators in the United Kingdom to paraffin flares elsewhere), the more significant problems stem from the application of advanced performance aircraft to existing route structures, where considerable differences are to be found throughout the World, area to area; and where overall advancement in associated services has never been in step with aircraft development and, in fact, continues to lose ground.

From such a platform it is interesting to note that in early 1962 the COM Division of ICAO holds its seventh meeting and that an agenda item will be "an exchange of views" on the establishment of a standard long-range navigation aid.

The position at the present time internationally, and in the absence of a "standard," is that the "interim aid" is Consol. But where regional circumstances demand it, Loran or non-directional beacons (NDBs) may fulfil this "interim" measure.

Considering the World as a whole, the absence of a "standard" as such has not proved to date to be serious. Some 90% of long-haul sectors are, of course, catered for, inadequately in some cases, by short-range navigation aids.

The chart, Fig. 1, illustrates the general picture to advantage. It was originally designed to define those areas where United Kingdom legislation required the carriage of a specialist navigator licence holder (it still does), but outside Areas A to J the holder of an ALTP licence meets the requirement; the basis being that there are sufficient short-range aids to make "pilot navigation" a realistic procedure.

Such navigational procedures are, therefore, possible on the routes to South Africa via Cairo; to India, Hong Kong, Tokyo and Australia; and additionally routes within the North American continent. Such routes as these do, however, contain what at best can be described as an unhappy mixture of "Controlled," "Advisory" and "Informatory" airspace. In isolation "Standard" or "Recommended" such airspace may be; but at the speed and altitude of the subsonic jet, collectively it all seems "highly irregular."

In accepting that real effort is being extended by ICAO we must call for better air traffic services and fewer procedural differences. Like the proverbial cake, you can't have your fuel and burn it!

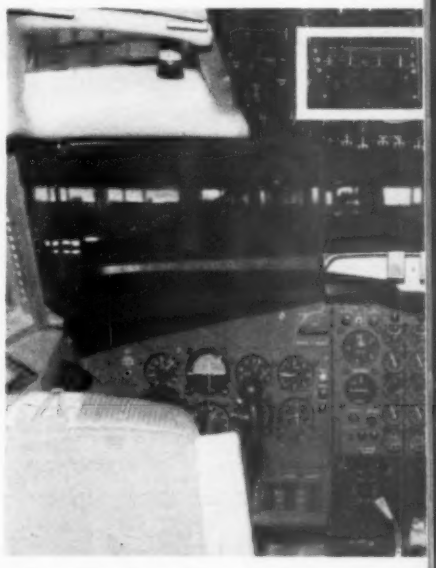
The remaining areas have a more significant effect than their 10% of the total suggests—first, because they introduce the "non-standard" element affecting all aspects of the operation and, secondly, because some of them are peculiarly important and traffic is relatively high.

There are signs, for example, that the North Atlantic Air Traffic System is creaking and that in the immediate future there will need to be an overall improvement in horizontal navigational accuracy, in particular, to facilitate a reduction in separation standards which, in turn, would provide some alleviation from delays or other restrictions to jet traffic, which is on the increase. In April and May of this year some 37% and 38% respectively of B.O.A.C.'s North Atlantic operations were restricted in altitude, track or time. This is, of course, a "special area" problem which will undoubtedly have a significant effect on action arising from the discussions in Montreal.

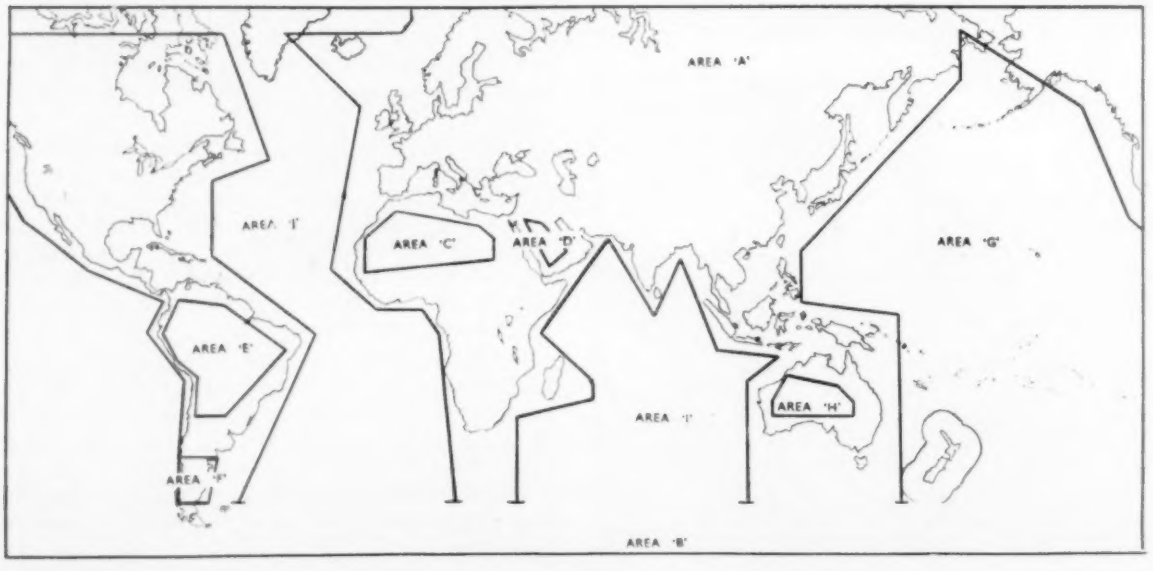
Utilization demands of jet aircraft have given rise to a large increase in daylight operations in general, and to North America in particular. Although the 24 hours is, therefore, being used more advantageously, apparently it is not enough to offset the traffic increases. Navigationally, this relatively new North Atlantic daylight feature makes significant the extremely limited "day" cover of Loran, the popular aid in that area and the Pacific.

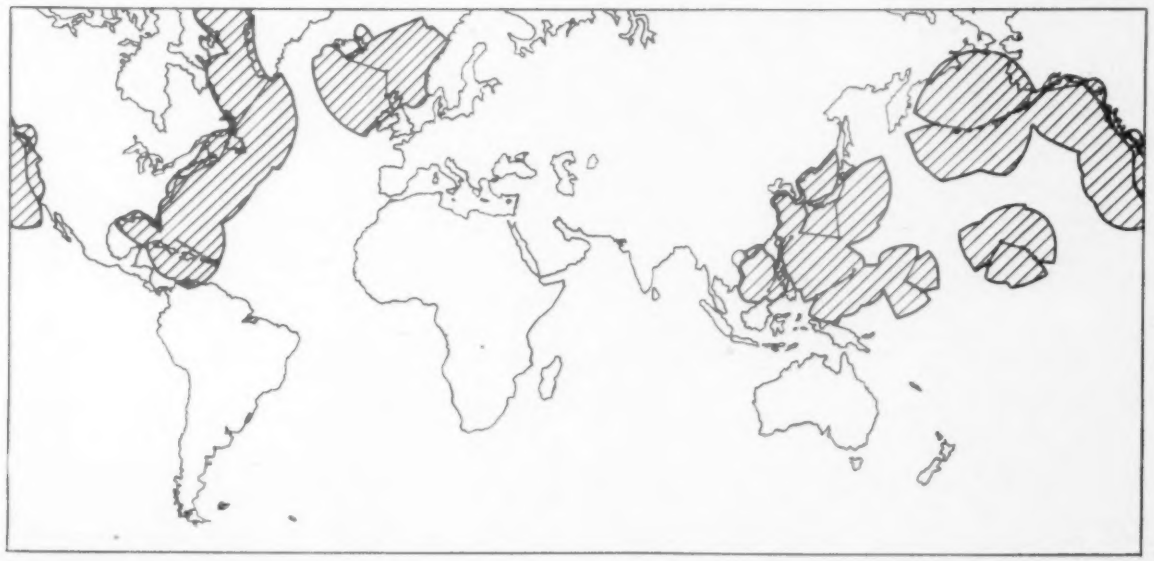
This "day" cover is shown in Fig. 2. Consol cover on the North Atlantic has not been included but is not, in effect, too dissimilar. In practice, Bushmills is received satisfactorily out to 30°00W Long. and about 1,000 miles range is received from

* Flight Services Manager, B.O.A.C.

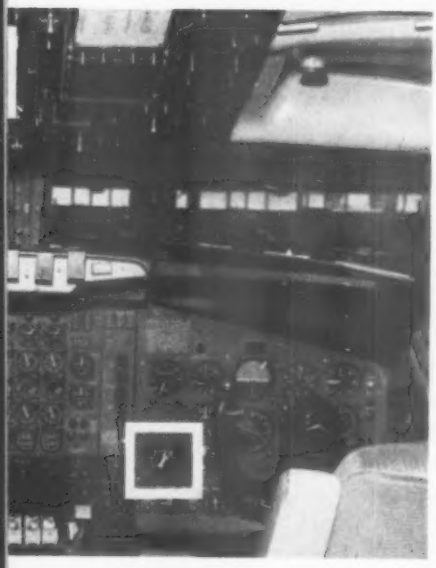


Below, Fig. 1.—Areas where inadequate navigational aid coverage necessitates carriage of a specialist navigator.





Above, Fig. 2.—The "day" coverage of the standard Loran service is denoted by the shaded areas.



Left, the airborne Doppler systems of the U.S., Canada and the U.K. will undoubtedly be considered at Montreal next year. Here the ground speed/drift angle indicator and the computer of a Doppler installation in a Boeing 720 are indicated.

Nantucket, which is sited on the eastern American seaboard.

In a daylight operation the gap in the centre of the "Red Herring" pond is significant and we are back on dead-reckoning navigation. The daylight story in the Pacific on the route Honolulu-Tokyo is clearly much the same.

The known long-range "bag" at Montreal is likely to include the ground-based aids Dectra, CYTAC (Loran C), Radio Web, Delrac, Navarho and Omega, all of which have had some international mention. In addition, it might be anticipated that the United Kingdom may be disposed to make some mention of its own VLF studies; and the airborne Doppler systems of the United States, Canada and the United Kingdom will undoubtedly be considered at that time.

In addition to the necessary technical merits and political aspects, which will bear heavily on any eventual decision of "standardization," "equipment availability" and "application time" will prove to be the most significant. For this reason, in particular, immediate attention will probably be focused on Dectra, Loran C and airborne Doppler.

Of the others, the feasibility studies of VLF which have been conducted in the United Kingdom have been reported on with so much favour that the enthusiasts, with a little justification, are talking of "major break-throughs of the long-range navigation aid problem at last." However, for technical and international reasons this answer is likely to be 10 years off. Development programmes covering suitable aircraft equipment should be put in hand as soon as possible if the 10 years estimate is to be achieved.

The United States Omega system can also be described as VLF operating in the 10-14 kc/s. band. Like Loran, it uses synchronized signals from master and slave stations. An operational evaluation is planned for late this year and an airborne development receiver is expected to be flying sometime this summer. Progress reports talk of "global coverage with a seven-station network."

Some form of VLF offers hope to the international operator of providing at last the necessary ground-based element of a total aircraft navigation system which could be used universally, the other element, of course, being self-contained equipment such as Doppler or Inertia-Doppler.

However, this is only in the foreseeable future but, nevertheless, it is near enough in time scale to render any action which might be associated with Dectra and the North Atlantic almost overdue if this system is to have a reasonable "life." Dectra's characteristics and application possibilities on the North Atlantic have been fully documented on many occasions. On the other hand, some readers will be less familiar with CYTAC (Loran C), which is a delevopment from existing Loran.

This LF phase-comparison system is a hyperbolic type and uses pulse techniques for range and ionospheric interference avoidance. The groundwave maximum range over water is about 2,000 miles; over land at worst about 1,200 nautical miles is achieved. The ionospheric wave range is around 3,500 nautical miles.

Three stations at Martha's Vineyard, Cape Fear and Jupiter, on the east coast of the United States, have been in operation since 1957, and it is now reported that an evaluation shows that Loran C stations can maintain a synchronization of 0.1 microseconds and that navigational fixes are available to an accuracy of $\pm\frac{1}{4}$ mile for a distance of 1,000 nautical miles using groundwave signals. First-hop skywaves are useful to about 2,000 nautical miles day and night, and it is possible to obtain line of position accuracy of two n. miles within the service area.

An estimate of the "useful air navigational coverage" provided by existing Loran C stations is shown in Fig. 3. This includes single-position line information. It will be seen that Loran C is established in the Mediterranean, the North Sea and the Pacific areas.

Even so, with the time scale and VLF developments particularly in mind, it is difficult to see any comprehensive international aviation application. The same can be said for Dectra. What may happen is that events in the North Atlantic area may force the issue such that the "interim aid list" is extended to include Dectra, in which case no doubt similar recognition for Loran C will be required.

The international operator, however, wishes to avoid different "black boxes" and associated procedures from area to area. Apart from the marked nuisance value of non-standardization in flight-deck procedures, aircraft are not confined to one area and we would inevitably finish up carrying all the aids as costly deadload for a large percentage of aircraft life. Experience indicates that route fitting and maintenance (changing black boxes en route) is not a practical proposition.

All major operators are progressively fitting airborne Doppler equipment and many expect this to provide the necessary degree of improvement in navigational ability and route flexibility and, with normal development, to tide them over the next eight years.

The expresssion "Doppler equipment" does, of course, cover

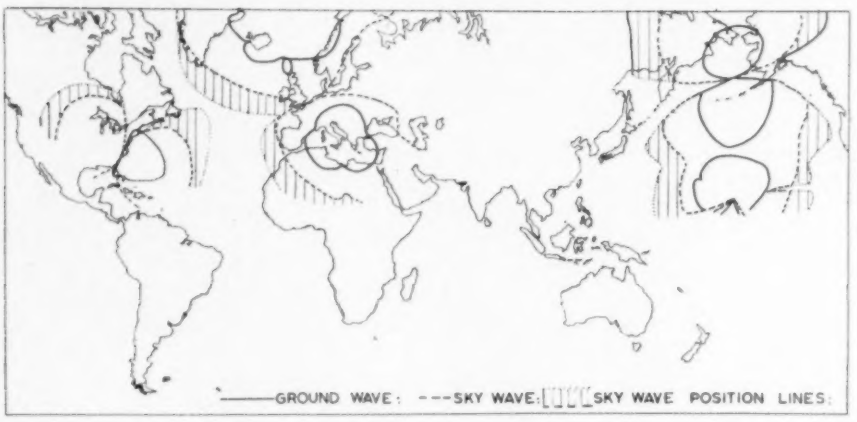


Fig. 3.—The estimated useful air navigation coverage of Loran C. This is not the total service area of the system.

a multitude of types. There are good grounds for assuming that "end product" accuracy varies significantly between the many available equipments, and if Doppler is to receive proper international recognition and, what is more important, international application on such areas as the North Atlantic, end-product accuracy must be established.

In the environment of normal civil operations, which do not include any special "heading reference" ground checks, it is doubtful whether the best of the bunch could be called better than a 97% (or 3%) system.

If an improvement on this is required for separation criteria purposes and special ground checks are not practical, then it may be necessary to consider a "poor man's" star tracker (short-time period automatic sextant). Something approximating closely to a 99% (or 1%) system would then be within reach.

Similarly, the operator anticipates that existing ground-based aids, subjected to normal development, will provide any back-up support required until an improved "global system" is available. It is understood that additional standard Loran cover might become available shortly in the Central and North Atlantic.

Jet operations have also highlighted problems in the vertical plane. These may be grouped under two main headings. First, those associated with the vertical structure of air traffic systems and associated procedures, and, secondly, aircraft navigational ability.

In the main, air traffic systems throughout the World rely very largely on vertical plane channelization for separation purposes, and the subsonic jet has accordingly been so conditioned. The individual aircraft requirement for freedom in this plane had to be subdued in the interests of safety and some cost can be associated with it. It might have been expected that, having accepted this significant restriction, level flight at least might be possible; unfortunately, even this is not the case. Vertical discontinuities are to be found at nearly all State or associated air traffic service boundaries, and sometimes even within a given area.

At the speed of the subsonic jet the frequency of crossing on some sectors is high and vertical changes need to be made irrespective of any performance requirements. Apart from the nuisance or workload value in the cockpit, quite clearly it is at such positions that there is a reduction in separation efficiency, and it is not surprising that air misses occur. This problem is, of course, recognized internationally and one sees the tendency towards the implementation of larger areas of influence in order to cut down the number of boundaries. Progress is, however, all too slow.

The vertical distribution of flight levels available to us on the sector Los Angeles-Saglek of the northern route to London is shown in Fig. 4. This particular route has no individual significance. It is one of many examples which could be given. But it will be seen that only two levels are available on one part of this sector, and if the aircraft has not made 37,000 ft. it must stay at 29,000 ft.

Another aspect of the same problem is associated with the use of other than the basic quadrantal rules. Although within such a large area as the United States, where a form of "semi-circular" rules is used, there may be advantages in strategically combining direction and Rules of the Air (Visual or Instrument Flight Rules); nevertheless, a problem is inevitably created at the boundaries of adjacent areas. More effort is required to provide protection to aircraft at such boundaries during the phase of climb or descent, and this could clearly be achieved through the use of ground-surveillance radar which, in many cases, is available for military reasons but has not yet been applied to civil systems.

Experience has fairly well established that whenever a flight path includes a significant change in the vertical plane it is difficult to be precise and make good air-traffic clearances. In descending from 40,000 ft. to 20,000 ft. at a fixed position ahead, significant changes in airspeed occur and on occasion the aircraft might be subjected to large meteorological forecast errors in wind velocity; all in all, it is extremely difficult to integrate rate of descent and forward speed in such a way that the aircraft can arrive precisely at the required altitude at a specified time.

This limitation in precision navigation in subsonic jet aircraft imposes a restriction on the use of "vertical" and "time" separation standards. If an improvement is to be effected then some assistance is required in the aircraft.

One other general problem which certainly can be associated with the long-haul operations in particular is the continual "state of change," both in facilities (aerodrome in particular) and procedures. The difficulty which this imposes on the operator, and indeed on the pilot, is that it is quite impossible to maintain an up-to-date flight documentation in a form which is capable of rapid assimilation. It is difficult to state precisely what the effect is on the pilot when he is subjected to such a state of change, but quite clearly it cannot be a good one.

There is an urgent need to consolidate in such a way that when changes are made they are regularized, so that basic documentation is up to date for a known period, with the exception of "unserviceabilities." In this respect the United Kingdom is taking an active interest and lead, and we are hopeful that its efforts will be recognized and copied throughout the World.

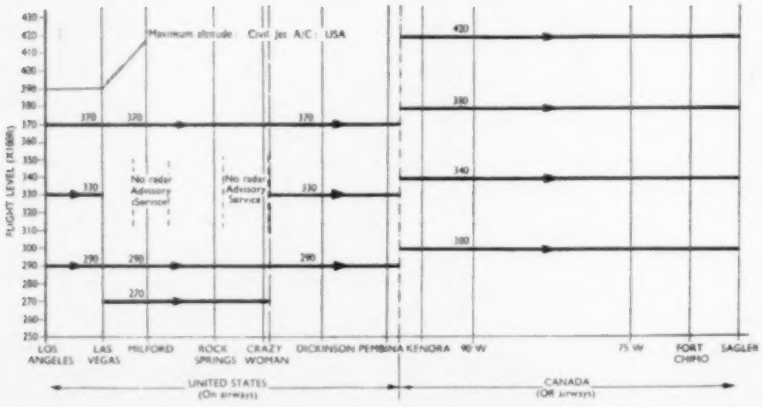


Fig. 4.—The vertical distribution of flight levels available to B.O.A.C. on the Los Angeles-Saglek sector of the northerly (eastbound) route to London.

Aero-Electronics . . . .

Civil Radar Data Handling

An account by H. L. A. Foy* *and* R. F. Hansford, F.I.N.* *of new display systems at Zürich and Geneva Airports*

THAT extra traffic-handling capacity is achieved when radar-derived data is used in conjunction with the procedural air traffic control system can scarcely be in doubt today. But the extent of the overall increase in capacity which is achieved when radar is employed in this way to monitor separations during the critical stages of a flight is probably far greater than is generally supposed.

In 1960 Dr. Hans Giesecke, chief scientist of the Federal Aviation Agency, provided comparative figures (Table 1) for Chicago (Midway) Airport with and without radar during similar IFR weather conditions. These extremely valuable figures, which could only be obtained because of a failure of radar during a large portion of one day of the observing period, tell their own story.

Dr. Giesecke further reports one analyst's attempt to estimate the direct cost of the extra delays and diversions on the non-radar day. Above $100,000 was his figure.

Table 1

	Average landings per hour	Average delay in minutes	Diversions
Radar	25.1	15	1
No Radar	18.1	35	33

Briefly, such is the background to any consideration of introducing immediate improvements in presentation of existing radar data and thus increasing the handling capacity of the several equipments which make up the airways and approach control radar system at the more important international terminals. While it is true that current development in every far-sighted official and industrial organization concerned now has as its aim the realization of new techniques for the full integration of radar with the procedural air traffic control organization—and the introduction of complex digital computers with dynamic display outputs for all data—these measures are primarily suitable for the very high-density traffic centre. They should not be allowed to confuse the issue as it affects the *average* international terminal today.

For many such airports, where traffic densities are most unlikely to reach 700 movements per day for some time to come, there are two principal methods of obtaining higher capacity today, within a realistic financial budget—better radar and better use of radar-derived data, i.e., improved data handling. Of the two, the last-mentioned may well offer greater possibilities and has certainly received all too little attention to date in civil air operations generally.

Of all the radar data-handling systems at airports falling within the broad category of "average international terminals," none are more advanced, or more interesting from an operational or technical point of view, than those at Zürich and Geneva. At both airports the newly fitted Decca display systems provide a means of co-ordinating radar data for control purposes from three separate radar equipments, of different manufacture, designed to fulfil different operational rôles.

The inter-switching of the six basic display viewing units, the means of transferring information between airways and approach radars and the several automatic controller aids provided on the displays are details—they are fully described below. The important feature is the bringing together of all radar data available at each control centre and the arrangement whereby radar, as opposed to a particular radar set, can be harnessed to maximum effectiveness to permit controllers to obtain high capacity from the existing procedural air traffic control system.

Zürich Airport

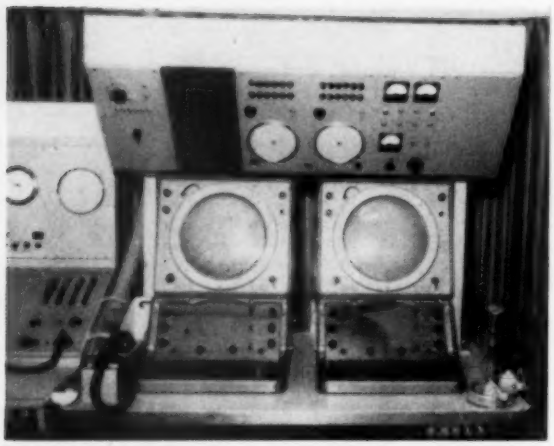
At Zürich there are at present two radars for which a new display and data-handling system has been installed, although a third is planned, and the system has been designed to be generally capable of being adapted to deal with all three eventually. The two radars in use comprise a Raytheon ASR-1 for airways control situated some 9½ miles remote from the airport and connected to the operations buildings by broad band link; and a Cossor ACR Mk. 6, primarily for approach control and situated about 650 yd. from the airport, connection being by cable.

There are six 12-in.-diameter display viewing units provided, each of which can operate with either radar as required. Four are situated in the airways control centre, while the remaining two are some 330 yd. away in the approach control building. The schematic diagram on page 74 shows how one complex is associated with each radar and a third is provided as stand-by in the present system, but is likely to be associated with the third radar at a later date.

Each complex contains, among other things, the basic interscan generating circuits for the data-handling facilities

* Decca Radar, Ltd.

Zürich International Airport where new display and data-handling equipment for air traffic control has recently been installed.



Two of the four Decca fixed-coil displays employed in the first stage of the Geneva radar data-handling installation. They are used in conjunction with CFTH 1081 and Marconi S.264 radars.

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appropriate to each radar, together with circuits which enable the various data-handling facilities to be provided on any display switched to accept the output of the complex. The interscan technique is based on a high-speed electronic switching system, which enables the time bases in the fixed-coil viewing units to be employed to show both the radar picture and the additional data-handling facilities. The output from the complex is fed to local waveform generators, which actually control the deflection of the electronic beam in the CRT of each display.

The ASR-1 complex incorporates two auto-follow tracking markers, which are used for inter-console marking. The operation of these markers is fully described below; suffice it so say at this point that they automatically follow the echoes of selected aircraft within the coverage of the airways control radar, at the same time appearing as symbols correctly positioned geographically on the approach control displays.

Inter-console marking of this nature has obvious advantages where control of aircraft is being handed from one controller to another. The facility is also of considerable use for showing the position of over-flying aircraft on the approach control displays as they pass through the cone of radar silence.

The other principal data-handling facilities provided on each display switched to the airways complex are as follows:—

RANGE AND BEARING MEASUREMENT LINE. This is an electronic line which appears on each display and is separately controllable at each position. It can be adjusted in length and direction to provide a rapid and accurate means of determining range and bearing data between any two points on the display. It has obvious applications for homing aircraft to any waiting position required.

CR/DF LINE. This electronic line on the display indicates bearings as obtained from the local CR/DF station at the airport. The origin of the line is automatically off-centred to the geographical position of the CR/DF station and the facility of presenting CR/DF information in the display is switched on, as and when required, by means of a push-button control.

VIDEO MAP. All displays are capable of accepting video map information, switchable between two channels.

MAINSCAN OFF-CENTRING. It is possible to off-centre the origin of the mainscan up to 175 miles in any direction. The preset origin of the CR/DF line is automatically moved when the mainscan is off-centred, and all other markers also retain their correct geographical significance.

The displays operating from the approach control complex have similar facilities as regards CR/DF, range and bearing measurement, mainscan off-centring (but only to 87.5 miles) and video map. This complex, however, also provides two runway centreline markers, which are displayed simultaneously on every display switched to the complex.

The origin position and direction of these markers are preset to three approach paths, any two of which can be selected by operator controls. The markers appear as electronic lines, extending 10 miles upwind from the end of each runway. Range marks are shown at two-mile intervals, measurement of range being from runway threshold.

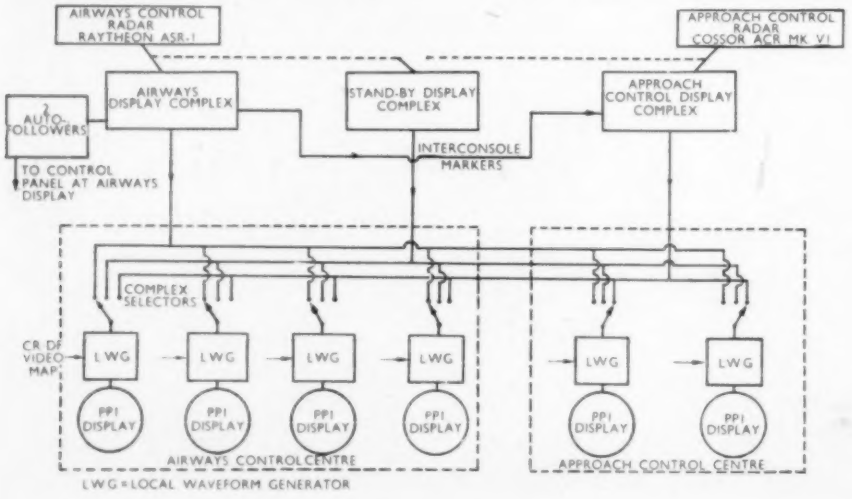
The displays operating from the stand-by complex, which is available for use with either radar, have reduced facilities consisting only of range and bearing line, CR/DF line, off-centring and video map.

Geneva International

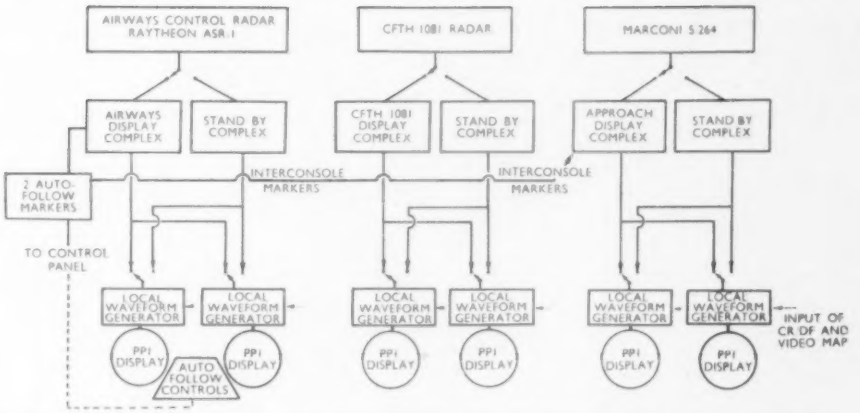
The planning of the data-handling facilities at Geneva was to some extent evolutionary and proceeded in two main stages. Stage One comprised the installation of four Decca fixed-coil displays with comparatively limited data-handling characteristics to operate from CFTH 1081 and Marconi S.264 radars. These four displays were all provided with similar facilities, comprising CR/DF lines and a video map showing runway markers, etc.

Before this equipment was fully operational, however, it was decided that an additional remote airways radar would be necessary, due to the considerable amount of high ground in the immediate vicinity of the airport, and arrangements were made to install a Raytheon ASR-1 radar on a mountain some 12½ miles from the airport, data from this radar being transmitted to the airport by broad-band link. At the same time, two additional displays were called for and the more sophisticated data-handling system shown in the schematic diagram on page 75 was devised to integrate all radars within a common system. The full display system is now in course of final installation and will closely resemble that fitted at Zürich as regards operational features when it is completed later this year.

As the diagram shows, auto-follow tracking is again provided on the displays operating from the Raytheon ASR-1 airways radar with inter-console marking to the other four displays which form approach control. The principal difference between this system and the one installed at Zürich is the arrangement whereby each radar is provided with one main and one stand-by complex, and the two displays operating with each radar can only be fed from either of their associated complexes. It is not possible to select the picture from any radar on any display.



Schematic diagram of the new display and data-handling system at Zürich Airport. Each of the six display viewing units can operate with either radar as required.



As shown in this diagram, the data-handling system for Geneva Airport has been devised to integrate all radars within a common system. The final installation will be completed later this year.

In addition to auto-follow and inter-console markers, the other facilities, which are virtually identical to those at Zürich, are: Raytheon ASR-1 radar, range and bearing line; CR/DF line; video map; two auto-follow markers. Marconi S.264 radar, CR/DF; video map; airways markers. CFTH 1081 radar, CR/DF; video map; airways markers.

Auto-follow and Inter-console Marking

While all the facilities at both Zürich and Geneva must be considered as a whole, since they are essentially part of a system, it is certainly true that the use of automatic tracking on the airways displays with inter-console marking of targets to the approach controllers' positions is the most interesting single feature and probably offers the greatest scope for further operational development. At present only two targets may be handled in this way, but the Decca system, based on military data-handling requirements, is designed to accommodate many more when necessary.

Auto-follow is manually initiated by means of "rolling-ball" type controls, which are used to set the initial position of the auto-follow track symbols on the airways displays. These controls are each associated with one of the two auto-follow tracks, which can be readily identified from each other since each has a symbol of different geometrical shape.

Immediately a symbol is positioned it appears automatically on every display connected to the airways complex; at the same time, DC voltages corresponding to its position, adjusted for displacement between the two radar aerials, are transferred to the approach complex and control the position of a similar symbol which appears in the correct geographical position on all approach displays. The symbol is automatically locked to the target echo on the airways radar and follows its movements without human intervention.

The auto-follow system is capable of making simple logical decisions when presented with either no data or too much data: whenever it becomes confused by either of these conditions warning lights indicate to the controller that his intervention may be required. If more than the one target being tracked comes within the auto-follow gate the system automatically proceeds on memory, i.e., tracks at the last course and speed, until the second target disappears.

Secondly, if there is no target within the gate, warning is given. In this case the auto-follow again continues on memory but, at the same time, the size of the gate is automatically increased to assist in finding the target when it reappears. The basic size of the gate can be varied, from a two-mile square to one with six-mile sides, by operator controls. Automatic expansion will double the chosen basic size in 20 seconds and treble it in 30 seconds if the target has still not been found.

Extensive trials in the United Kingdom have shown that operator intervention is only necessary approximately once per track per hour. These trials, however, were undertaken using a comparatively old radar and took place in an area of very high density where aircraft were being stacked.

It is anticipated that less intervention will be necessary with the type of radar fitted in Switzerland. Typical performance of the auto-follow system are:

(1) 95% target velocity determined in four aerial revolutions.

(2) Five-*g* turn followed through 360° at 600 knots, using a basic four-mile gate with radar data rate of 10 r.p.m.

(3) Three-*g* turn followed through 360° at 300 knots using a two-mile gate.

(4) Limiting aircraft ground speed—1,200 knots.

Aircraft velocity and direction, as determined by the auto-follow equipment, is not displayed on meters at Zürich or Geneva, but such meters would now normally be provided in the Decca system. Another refinement offering positive operational advantages is to display such information by means of an automatically adjusted vector line originating from the centre of the auto-follow symbol on the display. Length of this line is proportional to speed, while direction indicates aircraft ground track. Using equipment with this facility, it has been found that alterations in heading are detected and indicated much earlier by the auto-follow system than is possible by a controller studying the raw radar picture.

Conclusion

This description of the systems recently supplied by Decca Radar for radar data-handling and display purposes at Zürich and Geneva has been intentionally limited to an account of the equipment itself, the facilities provided and the general system arrangements adopted at each airport. Operational comment cannot be made until system operating experience has been acquired by controllers, although individually all the techniques have been fully tried out in the military field, and civil experience has been acquired at other installations with some of the facilities. The most interesting aspect of these two new installations is the introduction of automatic tracking and inter-console marking, hitherto not available in civil installations, but both offering great potential for implementing aircraft control procedures efficiently and for reducing the work load on controllers.

What has been described is sufficient to show that, without recourse to very high complexity or great expense, it is now practical for comparatively small control systems to be provided with advanced data-handling aids. While the systems designed for Zürich and Geneva were essentially individual, the electronic techniques employed to implement them were not specially developed for the purpose but formed part of the broad military and civil data-handling development programme which has been one of the main research and development activities of Decca for several years past, and on which work continues today.

This programme, although now concerned with the full integration of radar and procedural air traffic control by digital techniques, is fully capable of meeting more straightforward radar data-handling requirements and providing systems which offer prospects of substantial improvements in air traffic control methods within the existing procedural framework.

At Geneva Airport, as described in this article, new A.T.C. data-handling facilities are being installed.

Aero-Electronics . . . .

A.T.C. Research and Development

IN order to develop new Air Traffic Control techniques in the United Kingdom, the Ministry of Aviation has placed contracts for the installation of two experimental computer systems. The first, based on the Ferranti Apollo computer, is to be installed at the Oceanic Control Centre at Prestwick next month. The second, based on the Elliott 502 computer, is to go to the Air Traffic Control Experimental Unit at London Airport, Heathrow.

An experimental programme extending over more than three years is planned for the Apollo system and will include the investigation of the best uses to be made of automatic equipment; the standardization and regularization of data flow; the analysis of statistical data; and the determination of the requirements for, and testing of, different types of output and display equipment.

Being designed to accept and distribute A.T.C. data and complete the necessary calculations to operate electronic or electro-mechanical indications of flight-data displays, the Elliott installation will initially simulate the control of aircraft flying in the London F.I.R. The objects of this programme will include the development of new procedures; the improvement of the efficiency of the existing control system; and, perhaps, a revision of techniques.

In the two articles which follow, the main features of these two computing systems, together with their experimental application to operational A.T.C. problems, are described in detail.

1 *The Apollo Computing System*

by J. A. Llewellyn*

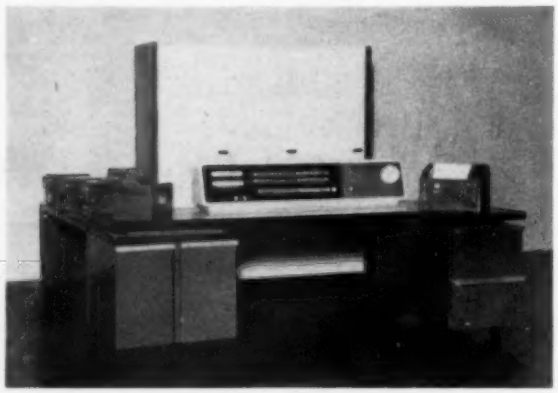
THE great virtue of the digital computer is that it can perform simple-arithmetic operations at very high speed. Also, once a programme has been written to perform a calculation, that calculation can be repeated any number of times on different sets of data, without human intervention.

The Apollo computer is given a wide range of calculating facilities including all the simple-arithmetic functions and methods of selecting and comparing characters such as are required in recognizing aircraft identities. The time taken to perform simple operations varies from 6 millionths of a second (for addition or character comparison) to 60 millionths of a second (for multiplication).

The Apollo computing system consists basically of a high-speed digital computer, housed in three cabinets, each 6 ft. high, 22 in. wide and 19 in. deep.

Positioned alongside the computer cabinets is a table housing three punches, each of which can produce results punched on paper tape at the rate of 25 characters a second. A control desk which is used for programme development faces the computer cabinets, on which stand two tape readers, a page-printer and the control panel with its hand switches and monitor lights. The maintenance engineer conducts his tests from the control desk using programmes to assist in detecting marginally faulty circuits.

* Computer Department, Ferranti, Ltd.



A scale-model of the Apollo computer to be installed in the Oceanic A.T.C.C. at Prestwick next month.

The computer receives situation reports from four teleprinter keyboards, each of which produces a printed copy for checking and record purposes. When the local operator is satisfied that the printed copy shows that the correct information has been set out, a special key is depressed indicating that the information can be transferred to the working store of the computer.

In the local operator's room there is a page-printer on which information is received from the computer concerning any queries about the input messages. The information input to the computer is held in a magnetic core store, capable of holding more than 4,000 numbers or 16,000 characters.

In the experimental control room there are two page-printers loaded with perforated paper on which flight progress strips are printed. Alongside each of the experimental control boards is a functional keyboard with which the controller can inform the computer of any control decisions which he has made or from which he can request information from the computer. There is a page-printer associated with each keyboard on which the controller receives information from the computer.

Over each control board, there is a cathode-ray tube by means of which the computer can display information to the controller far quicker than the message would appear on the page-printer. This cathode-ray tube has been developed by the Ministry of Aviation in conjunction with R.R.E.

Organization programmes are provided so that the A.T.C. programmer need not concern himself with the intricacies of the high-speed time-sharing and multi-channel input computer. The main programmes deal with all the "real time" situations as A.T.C. data are presented from the organization programmes. There will be comparatively long periods when no input information is requiring attention, during which subsidiary programmes are obeyed, the subsidiary programme not necessarily being related to the real time operations.

A programme consists of a series of instructions which are normally obeyed in sequence, except in the case of decision instructions which can jump to obey alternative instructions according to the result of a calculation. The instructions are punched on paper tape in a coded form which the computer can interpret when they are fed in through a paper-tape reader.

This information is preserved in a magnetic core store (separate from the data store referred to earlier) which is capable of holding more than 4,000 instructions. If a programme has to be altered for any reason, it is relatively simple to punch the amendment on a new paper tape and feed it into the computer through the tape reader.

Current Procedures in Oceanic A.T.C.

There are rigid traffic regulations in operation over the North Atlantic, to which all aircraft, whether civil or military, are subject. The separation between any two aircraft in the system

(*Continued on page 77*)

Wherever performance counts

the trend is towards 50cm radar for airways surveillance and terminal area control

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Ensures longer range for given transmitter power.

Penetrates thick weather without loss of efficiency.

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Know your airports . . . 7

WHAT'S GOING ON AT GATWICK?

Why is it London (Gatwick) now?
Because Gatwick—forty minutes by train from Victoria and about an hour by road from Central London—is playing an increasingly important part as London's second major airport. And as the London air traffic intensifies, Gatwick enters yet another significant phase in its history which dates back more than thirty years.

Was that when they built the circular terminal?
No, that came later. The aerodrome licence was granted in 1930 and initially the field was used for club and charter flying. The circular terminal—and a new railway station—were built as part of a subsequent expansion programme and the newly-developed airport was opened in June 1936.

And what about the racecourse?
That was absorbed as part of the aerodrome when Gatwick was requisitioned by the Air Ministry in 1939. After the war the airport was operated by the Ministry of Civil Aviation as a civil Customs aerodrome but its usefulness was limited by its lack of concrete runways. On March 31, 1956, flying ceased so that conversion of the site into a major new airport could be completed. Just over two years later, on June 9, 1958, the new Gatwick Airport was opened by Her Majesty the Queen.

What goes on today?
Some twelve airlines operate regularly from the airport. Scheduled services are flown to points within the U.K., to the Channel Isles, Europe and Africa; non-scheduled flights are operated to all parts of the world. Already two airlines have established maintenance bases at the airport and the BEA Helicopter Unit has been stationed there since 1951. Apart from handling routine traffic, Gatwick continues to serve as an alternative base in bad weather for aircraft normally operating from London (Heathrow). There is a wide variety of traffic at Gatwick and Esso provides safe, swift service for its customers, with an up-to-the-minute installation in keeping with an airport which was designed and built with tomorrow well in mind.

What's this helicopter doing?
This photograph, taken on May 17, 1958, shows a BEA Westland S-55 acting as a crane to position Gatwick's rotating light beacon on an 85-ft. tower in wooded country near the airport. This delicate operation is typical of the imaginative and determined way in which problems were tackled when designing and building the new airport. In consequence, London (Gatwick) today, with its first-class lighting and radio installations, its contrasting colour scheme for runway and shoulders to give maximum assistance when landing, and its unique combination of air, rail and road transport facilities in one unit, is an inspiring example of unsurpassed service for pilots and passengers alike.

This photograph shows Gatwick in its present form: a neat, modern airport with a futuristic look. But behind the bricks and glass and concrete of today lie long years of patient planning and preparation, of courageous decisions to anticipate future demands and of rapid and resourceful execution. These are the fundamentals, as vital to the building of a new airport today as they are to the provision of an efficient fuel service for the aircraft which it handles.

What are the fundamentals behind Esso's airport service?

- Products of the highest quality, produced in Esso's great refineries at Fawley and Milford Haven
- Research to evolve new products to parallel the aviation industry's development of new aircraft and new engines
- Development of engineering requirements necessary to meet the increasing stringency of aircraft turn-round, as well as operational techniques to keep pace with the new equipment
- Control of quality, ensuring that at each and every stage Esso products are up to specification
- Experience in serving the exacting needs of aeroplanes; and thorough training to pass on the fruits of that experience to those who follow.

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The only system capable of meeting all the navigational requirements of the jet age, the Decca Navigator provides high accuracy coverage over a wide area, regardless of altitude, terrain or climatic conditions. With the pictorial presentation of the Flight Log pilots can see all their required navigational information at a glance. All aircraft can maintain any pre-selected tracks with ease and accuracy and jets can be assigned climb and descent paths that permit them to operate safely and economically.

Over 7,000 ships and aircraft already rely on Decca—using the same system which operates from the ground upwards.

The Decca Navigator Company Ltd London

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(*Continued from page 76*)

must be at least two degrees of latitude; or 30 minutes longitudinal flying time; or 1,000 ft. in height, except in the case of high flying aircraft, when 2,000 ft. vertical separation is required.

The duty of the Air Traffic Controller is to ensure that all aircraft in the control area maintain adequate separation. When the controller sees that two intended flight paths will at some point infringe the separation standards, it is his duty to direct the aircraft to alternative flight paths which will achieve the necessary separation.

Before an aircraft enters the control area, the controller receives a flight plan, either from the departure airport or from an adjacent control region. The flight plan is a summary of the flight path which the pilot intends to fly, showing the height, latitude and time at which he expects to cross specified report positions. Before the aircraft is allowed to enter the control area, the flight plan must be cleared (i.e., the controller must satisfy himself that the aircraft will not infringe separation standards if the intended flight path is maintained).

The majority of the traffic is in an easterly or westerly direction and the report points are the meridians, the principal ones being at intervals of 10 degrees. The controller represents the flight plan by a set of flight progress strips written on paper and mounted in strip holders. There is one strip for each of the standard report positions containing all the relevant information including such items as height, latitude and expected crossing time.

These strips are laid out on a sloping flight progress board in a manner that enables the controller to build up a mental picture of the aircraft in his control area. As the aircraft make their position reports, the controller up-dates the corresponding strip and amends estimates for subsequent report positions if the report shows a significant departure from the intended plan.

The controller continually compares estimated positions to ensure that no conflict situation is likely to occur (i.e., that separation standards are not likely to be infringed). In the event of a potential conflict, the controller determines what flight plan modification will achieve separation and informs the aircraft of the modified plan to which it must adhere. Additionally, the aircraft may request clearance for an alteration to the original flight plan, which the controller approves if no resultant conflict situation is likely to occur. The clearance usually consists of a height change or a minor change in course.

Application of Apollo in Oceanic Experiments

The Apollo computing system has been developed to be sufficiently flexible to meet all likely requirements in the experimentation with, and evaluation of, improved Air Traffic Control systems in the Oceanic Area. The kinds of problem which may well be the subjects of experiments are conflict detection, conflict resolution, direct input of information, and alternative methods of displaying the necessary information to the controllers.

In the development of the system, the designers have envisaged the equipment being used in the following way, initially, in order to investigate to what extent the A.T.C. personnel can be relieved of the routine work which is necessary at present.

The "live" control will carry on in exactly the same way as at present with duplicate control boards manned by the experimental controllers in the experimental control room. All information received in the main control room will be passed on to the local operators who will type it into the computer on the local operator keyboards. The information will consist mainly of flight plans, departure times and position reports, although there will be other less frequent types of message such as arrivals, cancellations, etc. In the first instance, all messages will be scrutinized and typed according to standard formats, but as the experiments develop, computer programmes may be written to sort out the original message and test the validity of the information.

The computer stores the flight plans in the data storage as they arrive from the input keyboards, and up-dates them when an actual time of departure is received. There is a clock register in the computer which shows the real time so that at a specified time interval before an aircraft is due to enter the control area the flight plan is tested to ensure that no conflict situation will arise. The computer extracts the relevant information from the flight plan and prints flight progress strips at the appropriate strip printer located in the experimental control room.

These printers are loaded with paper of different colours so that it is easy to distinguish between eastbound and westbound aircraft. The strips are manually inserted in the strip holders and handed to the relevant experimental controller for display on the flight progress board.

On receipt of any message concerning a flight, edited information will be printed at the page-printer of the controller who is responsible for that flight. The flight plan in the data storage will be amended accordingly and if differing from the estimated flight plan, it will again be tested against all other flight plans in the system. If the computer determines that a potential conflict exists relevant information will be printed at the page-printers of all the controllers who are responsible for the aircraft with conflicting flight plans.

At frequent intervals, the computer will scan all flight plans in the store and if any position report has not been received within a specified time of the expected report, an overdue message will be displayed to the appropriate controller.

The controller decides on all actions to be taken and may request that further information from the computer storage be displayed to him, by using his special purpose input keyboard. Also, with the aid of his special keyboard he informs the computer of any action which he has taken so that the computer can up-date the flight information in storage.

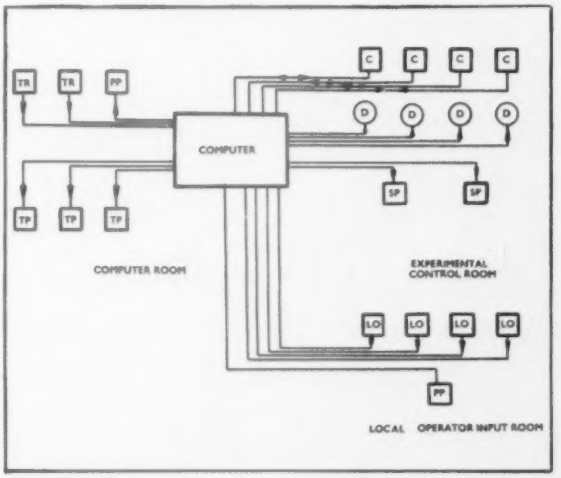
In the case of aircraft re-clearances, the computer checks that this will not give rise to further conflict situation and informs the controller that the clearance is valid. Future programmes may be written which will select alternative flight paths which are free from conflict, presenting them to the controller for his consideration.

A record of all information received by the computer from both local operators' and controllers' keyboards will be punched on paper tape at the tape punches in the computer room. This can be fed into the computer at a later stage for statistical analysis.

At the same time as the air traffic control computing is being performed, the computer will be carrying on other activities. Every second, a test programme will be obeyed which thoroughly tests the arithmetic and storage facilities using a set of arbitrary data, ascertaining that these are functioning correctly. If any error is discovered, notification is given at the computer control desk. The computer is provided with facilities for detecting errors at any input, which may have arisen due to faults in the peripheral equipment. Indication of detected errors are shown at the page-printer on the computer control desk.

Simultaneously, a programmer can be reading programmes into the computer and performing computations which are not directly concerned with the activities of the controllers or local operators. The kind of programmes which may be obeyed on this time-sharing basis are revision and improvement of the A.T.C. programmes to be incorporated in the main ones at a later stage; analysis of air traffic movements or possibly programmes which are quite remote from the Air Traffic Control activities.

By using the Apollo computing system for experiments of the nature described above, it is hoped to solve some of the problems of Oceanic Air Traffic Control and to determine what part automatic equipment can play in the easing of the data handling problems of the Oceanic controllers.



Schematic diagram of the Apollo computing system. Key: TR, tape recorder; PP, page-printer; TP, tape punch; C, controller keyboard and printer; D, controller display tube; SP, strip printer; and LO, local operator keyboard.

Aero-Electronics . . . .

2 The 502 Data Processor

by H. D. Mitchell*

EVOLUTION of the Air Traffic Control system in the United Kingdom has for many years been aided by the activities of the Air Traffic Control Experimental Unit of the Ministry of Aviation. At the A.T.C.E.U. new control techniques and procedures have been developed and new facilities evaluated prior to their introduction into the Air Traffic Control Centres. Extensive simulation facilities in the A.T.C.E.U. and close collaboration with the London Centre have enabled the work of the unit to be performed on a realistic scale in a near-operational environment.

In the future, the introduction of the techniques of automation into an Air Traffic Control system will require an even more extensive evaluation demanding experimental facilities of a correspondingly complex nature. Before this, the degree of assistance which automation can give to Air Traffic Control and the characteristics of the system employing these techniques must be established. The A.T.C.E.U., in conjunction with the Royal Radar Establishment, will play a major part in an experimental investigation of the problems of introducing automation into the United Kingdom A.T.C. system.

The main instrument which will be used in this investigation is the Elliott 502 " On-line " Data Processor and Display System recently ordered by the Ministry of Aviation from Elliott Brothers (London), Ltd., a member of the Elliott Automation Group. A standard unit in the company's range of stored programme digital computers, it is designed for use in automation systems which require high-speed data processing to be performed on demand and in " real time." Being a fully stored programme computer it is suitable for application in a wide variety of systems, it is made specific to each system only by the programme which it stores.

It is an all-transistor, parallel mode, computer in which the basic " word " of information is of 20 binary digits only. This short word operation enables computation, of an accuracy sufficient for the majority of " on-line " applications, to be performed economically and at very high speeds. Extended accuracy computation is readily programmed when required.

The compound magnetic core storage of the 502 enables an economic balance to be achieved in each system between the different requirements of large capacity and high speed access to stored information. In all systems a 1,024-word store of only 1 microsec. read-write cycle time enables simple operations to be achieved in times as low as 2 microsec.

Longer operations such as multiplication may occupy as little as 12 microsec. of the processor's time. The main computing store of the 502 has a very high potential capacity, each word of which is individually addressable. Dependent on the system requirements it may be composed of several units of either 8,192 words of 4 microsec. cycle time or 32,768 words of 24 microsec. cycle time, separately or in combination.

The data input and output facilities associated with the 502 will normally be specific to the system in which it is incorporated. In most systems both conventional data processing equipment and specially designed units will be connected to the 502 in varying quantities. Its design readily permits this with a minimum of special engineering and enables their operations to be controlled by specially written programmes stored in the processor.

In " on-line " data processing systems a common feature is the random timing of the demands which may be made for data processing activities in the processor. The demands may result in complex computations or in the transfer of data between processor and other units of the system, frequently both. Demands originating from different parts of a complex system may differ in the degree of urgency with which they must be satisfied.

A special feature of the 502 processor enables the more urgent activities to be given priority over those which are less critical. The order of precedence, determined by the requirements of the system, may be pre-set or programme variable.

These various features of the 502 give it the versatility necessary for its application to a wide range of automation systems. In particular they provide the flexibility required in the Air Traffic Control Experimental System. In this system, the 502 processor will be associated with a number of conventional data processing equipments and also with several units which will be designed specially for use in the system.

Conventional equipment which will be associated with the 502 processor includes its normal punched paper tape input and output equipment for programme input and supervisory control of the system. Two Elliott 35-mm. magnetic film file storage units will provide recording facilities for experimental data and significant results.

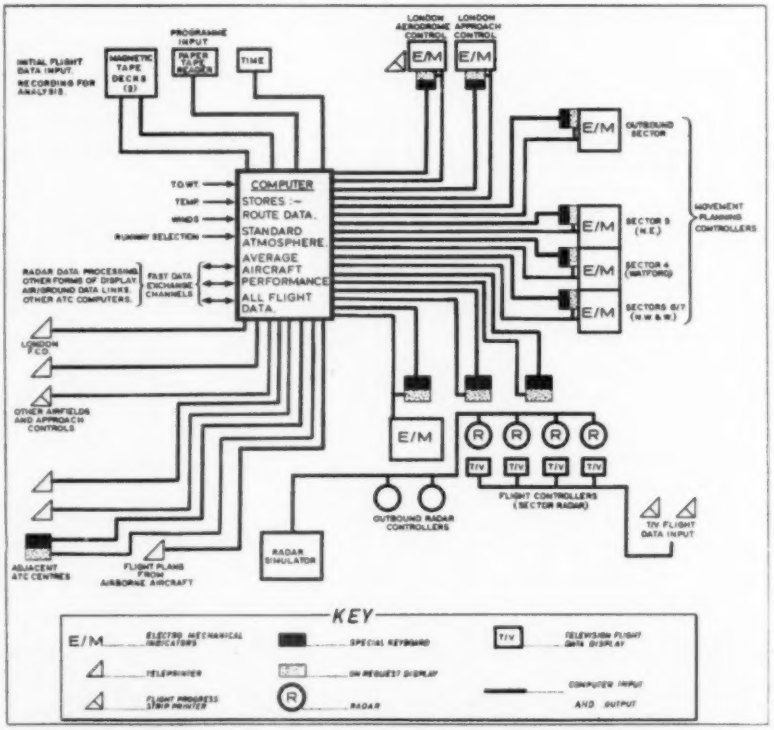
A number of teleprinters will be used directly " on-line " for input and output of data—an instance of conventional equipment being used in a less conventional manner. The facilities to be provided in the system will enable up to 16 of these to be connected and independently controlled by programme.

Initially fewer will be connected, some for input of flight data from various sources and others for printing flight progress strips during experiments. Any or all of the teleprinters may be in use, at maximum speed, at any time.

Special display facilities and keyboard units for use by controllers during experimental operations will be the major non-standard items in the system. These form a most important part of the system since the initial experiments are aimed at investigating their use.

The display facilities to be provided initially are based on the use of electro-magnetic indicators for the tabular presentation

(*Continued on page 79*)



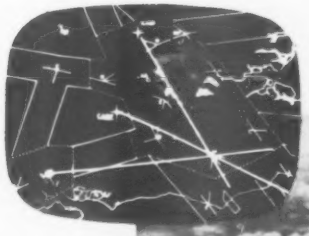
Layout of the initial experimental equipment in the Elliott 502 Data Processor and Display System for the Air Traffic Control Experimental Unit at Heathrow.

* Chief Systems Engineer, Special Computer Division, Elliott Brothers (London), Ltd.

STC Automatic d.f. Triangulation System Type PVT.2

- Utilizes the basic communication and control features of the PVT.1 and can be readily embodied in existing installations.
- Electronic facilities for plotting aircraft positions.

Television technique offers many advantages for information display in air traffic control and is being widely adopted. The display equipment for the PVT.2 automatic triangulation system employs closed-circuit television and represents a further stage in the development of the established STC triangulation system type PVT.1. This is a ground-based aircraft position-finder which has been in use, operating on regular v.h.f. communication frequencies, in Britain and elsewhere in Europe for several years.



- Assists identification of primary radar echoes of aircraft.
- Designed for use with STC wide-aperture d.f. systems (C.A.D.F.), the PVT.2 is adaptable to other direction-finders.
- The display can be reproduced on television monitors to suit individual requirements or by back-projection on to large screens.

Fuller details given in Radio Leaflet 312.

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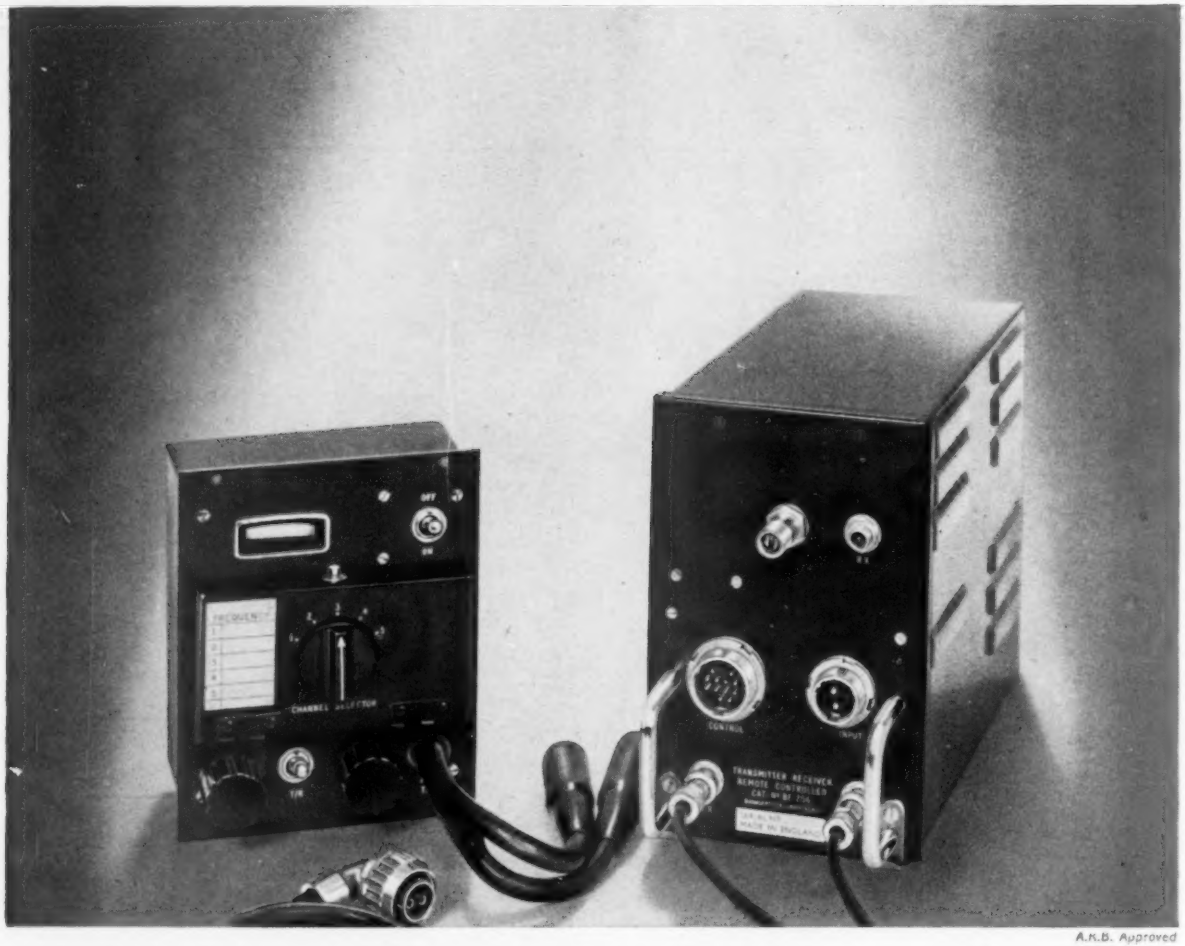

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Aero-Electronics . . . .

(*Continued from page 78*)

of flight progress data. The type of indicator to be used has been developed by N. V. Hollandse Signaalapparaten for a similar application in the second phase of their S.A.T.C.O. system to be installed at Schiphol Airport, Amsterdam.

Each indicator has a repertoire of 39 characters or symbols on an endless belt. The position of the belt, and thus the identity of the character displayed at the window on the end of the unit, is digitally encoded on seven "read-out" wires. The belt, driven by an internal stepping motor, is moved until the coded signal derived from it corresponds with the code of the desired character or symbol.

The display of flight data requires large numbers of those indicator units. The data for one aircraft at one position in a flight progress display may require up to 40 or more characters. In this experimental system, groups of up to 40 indicators in two rows of 20 will form a separately identifiable strip of flight progress data.

A push button and three lamp indicators, in white, green and red, will be associated with each separate strip. All of the indicators inserted in such a strip will be operated simultaneously when the data displayed by them is changed.

Groups of 10 strips will, in the experimental system, form removable display modules which will be mounted in varying numbers in the display consoles. Two different console designs, capable of containing four and eight modules respectively, are envisaged. The larger type of console will represent the flight progress boards at procedural controllers' positions; the smaller type will be used for presenting tabular information to "outbound" radar controllers and to positions representing the Aerodrome and Approach Control at Heathrow.

Further special display units, smaller than the interchangeable modules, will enable up to 60 characters of tabular information to be presented to the sector radar controllers close to their radar displays.

At each of the controllers' positions in the experimental system, keyboards of a special design will enable the controller to enter new or amended flight data into the system. An alpha numeric keyboard, for single handed operation, will enable significant information to be entered whilst a separate functional keyboard will indicate its significance and the operations to be performed on it. The functional keyboard will also enable a number of data-processing or display activities to be initiated "on demand" by the controller.

Display and keyboard equipment in the experimental system will enable a centre of approximately one third of the size of the London Centre to be represented. The interactions between controllers in different sectors, between procedural and radar controllers, and the use of the automatic flight progress displays will be investigated on a scale sufficient to achieve a high degree of realism. The near operational realism will be further heightened at the A.T.C.E.U. by the use of simulated telephone and radio-telephone facilities, a radar simulator and previously prepared flight-plans input at the appropriate times during exercises.

Initial Operations

The experimental system will be called upon to perform many different activities during the initial experiments within the simulated environment. These can best be described in relation to the various activities currently involved in an air traffic control centre in ensuring the safe transit of an aircraft from one airport to another.

Before departure on any flight in controlled airspace, the pilot of an aircraft must file his flight plan, its call sign, type and the various facilities carried by it. The intended route from departure to destination aerodromes, the desired altitude and the air speeds at different stages along the route are recorded on the flight plan. The estimated time of departure and the pilot's estimates of elapsed time are also entered by him on this document.

When a flight plan is filed at an aerodrome or airport flight clearance office the essential flight data, aircraft and route information, is extracted from it and sent to the aerodrome control and to the Air Traffic Control Centre. In the current operational system this is generally by telephone or, occasionally, by teleprinter.

In either case the flight plan information is recorded on a strip of paper, a Departure Flight Progress Strip, for subsequent use. In the experimental system the information extracted from flight plans will be fed directly into the system by means of the "On-line" teleprinters and stored within the computing store of the 502 processor.

When the aircraft is ready for departure, the pilot requests a "clearance," i.e., permission to fly along his planned flight path from the Aerodrome Control. This clearance request is relayed to the "outbound" controller at the A.T.C.C.

In current operations this is done by direct telephone links, in experiments the direct teleprinters will be used for requests supposedly originating from aerodromes other than London Airport. In the special case of London Aerodrome Control a display console and the keyboard associated with it will be used. The flight plan information for aircraft leaving London will be displayed to the ground movement controller a few minutes before the estimated departure time or "on-demand" when a clearance request is to be made.

A clearance request results in the flight plan information of the aircraft being displayed to the outbound controller on his display console. Already displayed on the console will be the flight data and clearance information for all aircraft recently cleared. Making use of this and knowledge of the state of availability of radar facilities, the outbound controller will formulate the clearance to be given to the aircraft.

Using his special keyboard facilities the outbound controller will enter the clearance into the system, to be displayed to him and to the appropriate aerodrome controller on their respective consoles, or by teleprinter. Outbound radar clearance will be displayed also to the outbound radar controller on his display console.

En Route Control

On the pilot's acceptance of the clearance, which may be amended if unacceptable, the aircraft is ready to depart subject to any time restrictions imposed by the clearance or, subsequently, by the outbound radar controller. When the aircraft is airborne the actual departure time will be entered into the system by means of the keyboard at the London Aerodrome Control, or by teleprinter if elsewhere.

On receipt of the departure message the full flight profile of the aircraft will be computed, on the basis of performance characteristics, meteorological conditions and clearance restrictions stored in the processor. The estimated times and heights of the aircraft at each of the reporting points along its route will be displayed to the appropriate sector controllers on their consoles along with other relevant flight data. During the flight profile computation potential confliction of the aircraft with other aircraft in the system will be checked and, if detected, will be indicated to the appropriate controller by a lamp.

The progress of an aircraft along its planned path is reported by the pilot at each of the mandatory reporting points. The actual times and heights at reporting points, if significantly different from estimates, will be entered by the controllers on their keyboards. Such up-dating will result in re-computation of the remaining part of the flight profile with further conflict prediction included in the operation.

Hand-over of control of the aircraft from one sector to another within the centre will be effected with the aid of the special keyboards and display facilities in order to speed this liaison. Similarly, hand-over of aircraft from one centre to an adjacent centre will be effected by means of the keyboards and teleprinter or high-speed data links.

Estimates received in this way from an adjacent centre, simulated in the experimental system, will be assimilated directly into the processor store and displayed to the appropriate controllers at the appropriate times.

In dealing with inbound aircraft, the experimental system will indicate to controllers the descent path appropriate to the aircraft, the computation of descent profile will be based on the aircraft operating characteristics, meteorological information and the known landing pattern stored within the processor. The hand-over of control of an inbound aircraft from sector to stack controllers and from stack to approach control will also be aided by the use of the keyboards and display facilities, which each will have. The aircraft flight data will be finally cleared from the system only when its actual time of arrival has been reported.

This brief description outlines only some of the major features of the initial operations which will be possible with the experimental system. At a later stage, flight information derived from radar will be assimilated by the system, using facilities which will be available initially.

The system will be used for the assessment of new techniques and procedures of control and for the evaluation of automation facilities which may eventually be incorporated in an operational system. Whilst these activities may need many new computer programmes they will require only a minimum of physical change to the original equipment.

In providing a tool of such flexibility the Elliott 502 "On-line" Data Processor will contribute much to the development of the future Air Traffic Control system. In the course of its experimental activity at the A.T.C.E.U. many of the operational problems of utilizing automation techniques in Air Traffic Control will be investigated. It is hoped that this will help speed their introduction into an effective control system which will be capable of meeting the increasingly heavy demands which will be made on it.

Aero-Electronics . . . . Airborne and Ground Navigation/

DESIGNATION	PRINCIPAL MANUFACTURERS	RANGE	FUNCTIONAL USES AND OPERATIONAL FEATURES
NAVIGATIONAL AIDS			
Ground Based and Operated			
Automatic Triangulation System	Marconi, Standard Telephones	—	Triangulation aircraft fixes provided by an instantaneous display of aircraft position on an illuminated map-screen. Bearing information obtained by a number of VHF/DF or UHF/DF stations and passed by landline to display centre.
C.A.D.F.	Standard Telephones	Line of Sight	A commutated antenna direction-finding system applicable to the HF, VHF and UHF bands. Employs normal automatic cathode-ray tube bearing presentation.
VHF/Direction Finder	Ekco, Marconi	Line of Sight	Automatic presentation of aircraft bearing information using standard VHF transmissions. Presentation normally on a cathode-ray tube display.
Ground Based, Airborne Operated			
Automatic Direction Finder (Radio Compass)	Bendix, Collins, Elliott, Lear, Marconi	Varies with beacon power	Provides the actual bearing of a radio transmitter (i.e. NDB) from the aircraft. An omni-directional pilot-operated aid, its bearing information is presented on a 360° dial.
Consol	No longer in production	1,200 n.m. plus	A navigator's aid requiring time to obtain a fix. Transmitting in the MF band, the ground stations produce a rotating pattern with 15°-wide lobes; chart or tables required to identify the sector in which the aircraft is flying. The approximate position must also be known.
Decca Navigator	Decca	Chain coverage 200 n.m.	A hyperbolic area-coverage system working on the principle of comparing the inter-related transmissions from one master and three slave radio stations. Meter and pictorial (Flight Log) display of continuous position line information.
Dectra	Decca	Approximately 2,000 n.m.	Long-range variant of Decca employing two stations at each end of the route being covered, the inphase patterns along the route providing both ranging and tracking information which is recorded on a Flight Log and two meters.
Distance Measuring Equipment (DME)	Collins, I.T.T., Federal, Murphy	Up to 200 n.m.	A pilot-interpreted aid providing range and heading facilities in conjunction with a standard transponder beacon. Information displayed on combined range and heading meter.
Gee	Cossor	450 n.m.	A hyperbolic fixing aid operating on a time-comparison technique. Extremely accurate, Gee position lines are displayed by means of a cathode-ray tube.
Global VLF	Under development by R.A.E. Radio Dept.	6,000 n.m.	Global system employing airborne high-stability oscillators and twin-channel receivers for providing aircraft position information relative to two of any six VLF transmitting stations. Fixes, plotted on families of circles centred on these two transmitters would be presented to the pilot in lat. and long., etc., or as flight plan correction information.
Loran	Edo, Redifon	Night: 1,500 n.m.; Day: 500 n.m.	Operates on the same principle as Gee with a cathode-ray tube information presentation. Fixes obtained by two readings on two different chains.
Loran–C (Cytac)	—	Over 3,000 n.m. at night	Similar to standard Loran, but with a greater accuracy and range. With only two ground stations highly accurate direction finding together with distance measuring of the order of one part in 90,000 at 1,500 n.m. range can be obtained.
MF NDBs, Locators and Markers	Redifon	Up to 2,000 n.m.	Non-directional homing and navigational beacons. Ground-air communication facilities available with some installations.
Omega	Under development in United States	—	VLF system operating in the 10–14 kcs. band. Like Loran, it uses synchronized signals from master and slave stations. Possible global coverage with a seven station network.
TACAN	Collins, Elliott, Hoffman, L.N.T., S. E. Lorenz, Standard Telephones	0–200 n.m.	Pilot-operated rho-theta system aid, providing continuous bearing information on a 360° dial; slant-line distance information to the ground beacon presented in miles by veeder counter.
VHF Omni-range (VOR)	Bendix, Collins, Marconi, S. E. Lorenz, Standard Telephones, Wilcox	Line of Sight	A point-source aid employing a phase-comparison system providing course and position information relative to ground stations. Visual cockpit presentation includes left/right deviation indicator, reciprocal bearing and to-from information.
VORTAC	—	Line of Sight	A compromise system employing ground stations each having a TACAN and VOR beacon co-located. Civil aircraft use VOR for bearing information and the distance measuring part of TACAN.
Self-contained and Airborne Operated			
Doppler	Bendix, Canadian Marconi, Collins, Decca Radar, Elliott, General Precision, LFE, Marconi, Ryan	—	Basic system provides continuous ground-speed and drift-angle information. With computer other navigational data, such as ground position and miles flown, can be displayed.
Inertial	Bell, Bendix, Bosch Arma, Elliott, English Electric, General Precision, Sperry	—	A dead reckoning method of navigation employing a stabilized platform. Two distinct systems: one uses the double integration of two horizontal accelerometers to determine displacement from a known point; the other measures the required platform rotation to maintain the vertical in calculating position change.
Weather Radar (Airborne Search Radar)	Bendix, Collins, Ekco, Elliott, R.C.A.	150 n.m.	Provides long-range pilot information on storm areas, can be tilted for map painting. Miniaturized equipment and bright cockpit display.
APPROACH AND LANDING AIDS			
Ground Based and Operated			
Automatic Landing System	Bell Aircraft	3–5 n.m.	Employs a precise automatic tracking radar and command computer with VHF data link to transmit ground-derived commands to the approaching aircraft. Requires no additional airborne electronic equipment.
GCA or Precision Approach Radar (PAR)	Bendix, Decca, Ekco, Gilfillan, LFE, Standard Telephones	Search Radar 30 n.m.: Precision Approach 8 n.m.	Used on airfields to provide accurate information on the position in elevation, azimuth and range of an approaching aircraft relative to the touch-down point on the runway. Automatic GCA incorporating extra ground computing equipment and special aircraft instruments, and semi-automatic GCA employing automatic tracking, computing and recorded voice transmissions but with full pilot control, are under development.
Ground Based, Airborne Operated			
ASV.23	Compagnie Générale de Télégraphie sans Fil (CSF)	—	A microwave system under development as an ILS replacement for providing azimuth and glide-path approach guidance. Ground transmitter, localizer, glide-path and DME aerials housed in trailer sited near touchdown point. Airborne equipment comprises aerial, receiver, cross-meter and distance indicator.
B.L.E.U. Autoland	Elliott, Marconi, Murphy, Pye, Smiths, Standard Telephones, in conjunction with R.A.E.	30 n.m.	Pilot-monitored automatic landing system employing several phases of guidance covering ILS glide, magnetic leader cable, constant altitude and radio altimeter during approach and landing. Accuracy: lateral error less than 10 ft., heading error within ½°, touch-down within 250 ft. Two microwave guidance systems—leader beacon and ASV.23—are under evaluation as possible leader cable replacements.
Instrument Landing System	Elliott, Marconi, Pye, Standard Telephones	Up to 30 n.m.	A pilot-presentation system employing a single cross-meter to indicate his azimuth and glide-path positions relative to a correct approach line. Ground transmitters comprise localizer, glide-path transmitter and range-marker beacons.

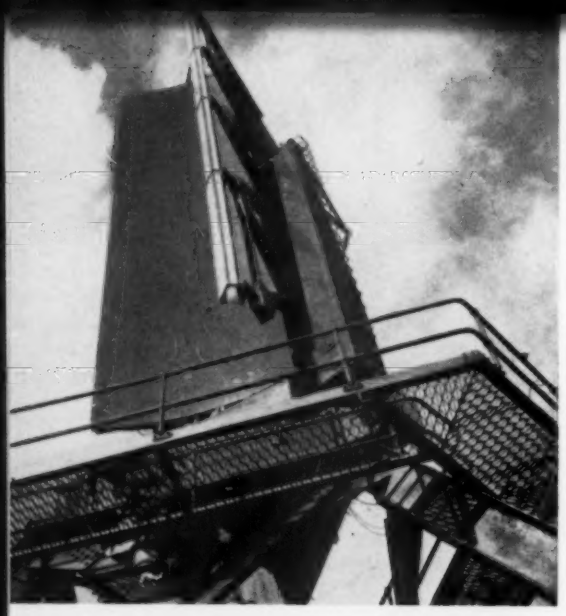
A.T.C./Communication Equipment

DESIGNATION	PRINCIPAL MANUFACTURERS	RANGE	FUNCTIONAL USES AND OPERATIONAL FEATURES
APPROACH AND LANDING AIDS			
Ground Based, Airborne Operated			
REGAL	Gilfillan, in conjunction with U.S. Federal Aviation Agency	10 n.m.	Provides automatic range and elevation guidance as the first step in the F.A.A. programme to evolve an advanced landing system; azimuth guidance facility to be added later to form a complete landing aid. Monitored by both pilot and ground controller, REGAL is based on Gilfillan Type AN/GSN–6 landing-control equipment.
Self-contained and Airborne Operated			
Radio Altimeter	Bendix, G.E.C., Standard Telephones	Height 0–5,000 ft.	Accurate height indication, normally to within 3% of the selected altitude scale. Sensitive to small changes of height.
AIR TRAFFIC CONTROL AIDS			
Ground Based and Operated			
Airfield and Approach Radar	Cossor, CSF, Decca, Gilfillan, Marconi	Up to 50 n.m.	All-round coverage up to various ranges primarily providing azimuth information down to the final stages of the approach. Some measures of circuit and overshoot control is also normally provided.
Airfield Surface Movement Indicator	Decca	—	Radar control and supervision of airport surface movements. PPI display plots runways, etc., and all traffic moving or stationary on the airfield. Aerial normally mounted on top of control tower.
Airways Surveillance Radar	Bendix, Cossor, CFTH, CSF, Decca, Marconi	100–200 n.m.	An A.T.C. aid for the en route supervision of aircraft flying Airways. Gap-free coverage and high definition PPI displays operating in conjunction with height-finding radar.
Height Finding Radar	Decca, Marconi	150 n.m.	Operates in conjunction with various plan radars to provide complete three-dimensional aircraft-position information.
Storm Warning Radar	Bendix, Cossor, Decca, Elliott, Marconi, Raytheon	Up to 250 n.m.	Presentation of an accurate plan picture shows the location of storms and rain-producing clouds. Functions usually include plotting of electrical disturbances and tracking of hurricanes, etc.
Terminal Area Radar	Cossor, Decca, Marconi	100 n.m. plus	Early identification of approaching aircraft at extreme range and feeding them into other types of approach aids. Aerial systems, etc., providing high definition and data rate together with uncluttered PPI displays incorporating video mapping.
Wind Finding Radar	Cossor, Decca	—	Operates by tracking a balloon borne passive reflector to provide information on high-altitude wind conditions.
Ground and Airborne Operated			
Airborne Secondary Radar Transponder	Cossor	200 n.m.	A combined receiver/transmitter which replies to a suitably coded interrogation from a ground transmitter. Coded pulse replies can be used to provide the A.T.C. controller with information on the height or identity of the aircraft, as well as its range and bearing.
Ground Secondary Radar System	Cossor	—	Generates the interrogator signals transmitted to transponder-equipped aircraft and receives the coded replies for display on a PPI presentation.
Self-contained and Airborne Operated			
VERDAN Digital Computer	Autonetics, Elliott	—	Combined solid state digital differential analyser and general purpose computer for use in aircraft guidance and control systems.
AIR/GROUND COMMUNICATION SYSTEMS			
High Frequency	Collins, Elliott, Marconi, Murphy, Redifon, Standard Telephones	Up to 3,000 n.m.	Provides long-range aircraft-to-ground communication, including radio telephony. Usually pilot-controlled with tunable channel selection. Additional operational features include the use of selective calling and aircraft identification systems.
Radio Teleprinter	Marconi, Standard Telephones	—	Airborne equipment for automatically recording "ready-to-read" meteorological and navigational reports transmitted by ground stations. Four receiving channels in the 90–130 Kc/s. frequency range.
SARAH	Ultra	70 n.m. at 10,000 ft.	Search and rescue and homing system operating in the VHF range to provide accurate location of aircraft accident survivors. Military version fitted with speech facility.
Very High Frequency and Ultra High Frequency	Bendix, Burndept, Collins, Cossor, Elliott, G.E.C., Lear, Marconi, Murphy, Narco, Plessey, Pye, R.C.A., Redifon, Standard Telephones	Line-of-sight: 100 n.m. at 10,000 ft.; Scatter VHF: up to 550 n.m.	Pilot-operated communication systems incorporating automatic crystal-controlled channel selection. VHF operates in the 108–138 Mc/s. frequency range while UHF aeronautical navigation/communication equipment has approximately six reserved bands in the 300–3,000 Mc/s. range.

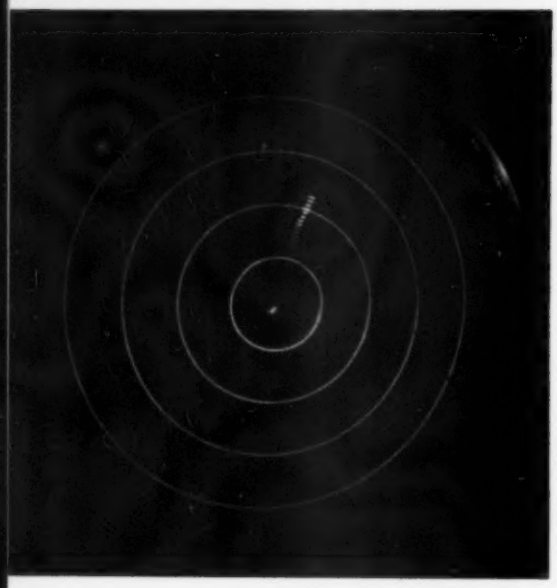
DEFENCE RADAR.—The post-War re-equipping of the U.K. ground radar defences was undertaken by Marconi, who were responsible for the handling of the design of the equipment, the planning of the mobile and static stations and the installation of the entire chain. Here, part of a track reporting centre with PPI consoles, height/range display and VHF frequency selector consoles can be seen.

Aero-Electronics . . . .

Aids to Navigation and Control

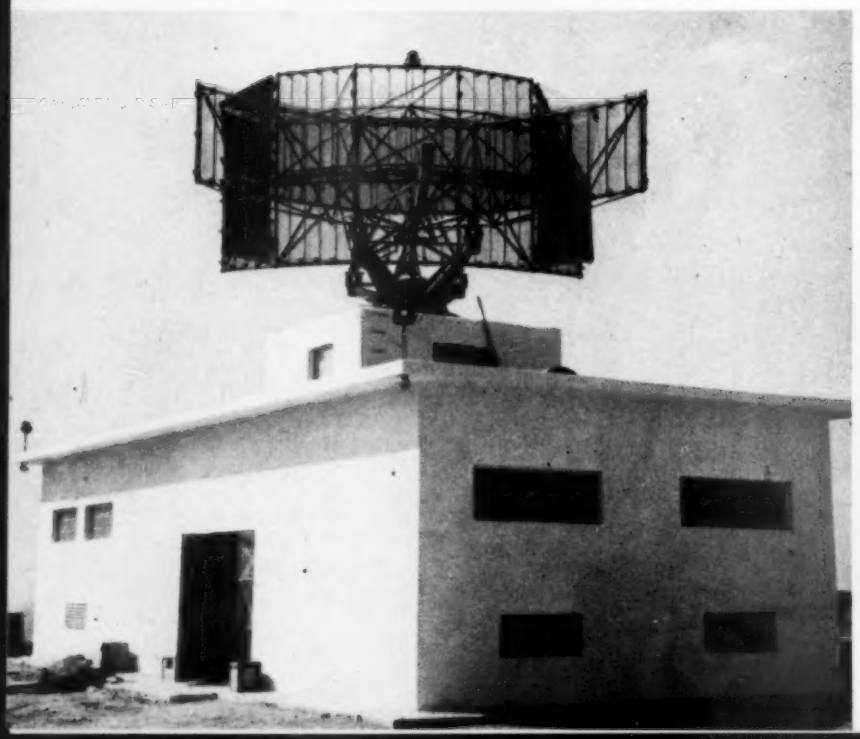


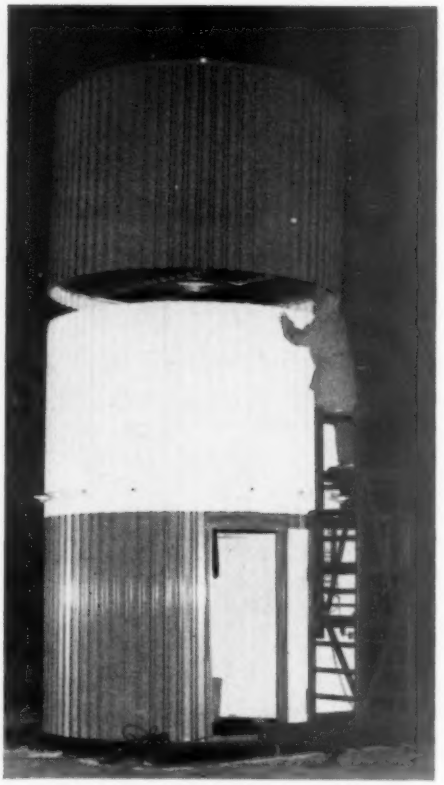
Left, a Marconi Type S.244 10cm-band high power height-finder radar. This equipment has an absolute height accuracy of ± 1,700 ft. at 150 nautical miles.



Left, the progress of an aircraft on a secondary radar display at the S.A.T.C.C. at Heathrow. The signals in this picture were obtained by the Cossor SSR 4G interrogator-responsor.

Below, the aerial system of the Decca DASR-1 at Caracas, Venezuela. At a range of 100 miles, this radar can detect small modern airliners at 40,000 ft.





Above, assembling a Standard Telephones VOR beacon at New Southgate prior to testing. The 10 ft. dia. installation is designed for unattended, remotely controlled operation.

Below, the Bendix CNA-24A navigation computer controller employed in the company's Doppler navigation system to be manufactured in the U.K. by Elliott Brothers (London), Ltd.

Bringing Space Down to Earth

A GIANT new research tool for astronautics is under construction at the Jet Propulsion Laboratory of the California Institute of Technology. Designed to simulate conditions which future space probes will encounter in outer space, the "space environment simulator" is being built for J.P.L. by a team of industrial concerns headed by Consolidated Vacuum Corporation of Rochester, New York. It is expected to be completed by the end of the year.

The facilities consist of an office building, a control room, an equipment area, and the space simulator. The simulator is a cylindrical tower 80 ft. high and 27 ft. in diameter. Contained within the lower part is a stainless steel vacuum chamber measuring 47 ft. high by 25 ft. diameter where the spacecraft will be tested. First of the space vehicles scheduled for testing in the chamber is Mariner A, the 1,000-lb. Venus probe which stands 8 ft. tall and has a spread of 19 ft. when its solar panels are extended.

Problems of Radiation

The urgent need for creating a simulator of this type has been outlined by Mr. Herbert D. Strong, head of the Wind-tunnels and Environment Section at J.P.L. "Space is characterized by an absence of heat and pressure," he points out. "It is a perfect vacuum where temperature, as we know it on Earth, does not exist unless there is some object to intercept the radiant heat from the Sun."

Because the only energy in space is that radiated from the Sun (and other stars), the temperature of an object, such as a spacecraft, will depend on several factors: its distance and orientation relative to the Sun, its colour or finish, the material of which it is made, and its shape.

A dull black ball would absorb more heat in space than a shiny silver ball, and thus would be warmer. But if this ball happened to be made of a material that was a poor conductor of heat, only the side facing the Sun would be hot. The other side which faces dark space would be extremely cold.

Mr. William R. Howard, head of the Engineering Facilities Division, adds that in designing something as complicated as a spacecraft, conditions such as these (where hot and cold areas exist simultaneously in the vehicle) can lead to considerable difficulties. Electronic components might freeze or bake, batteries could stop working and sensitive measuring devices might be rendered useless.

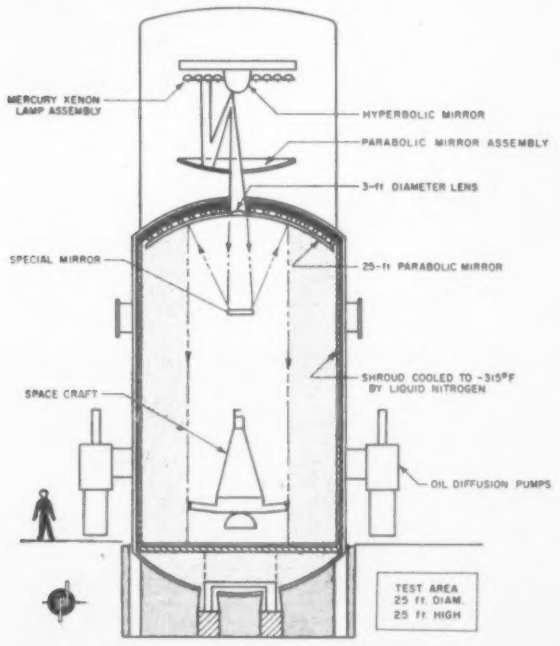
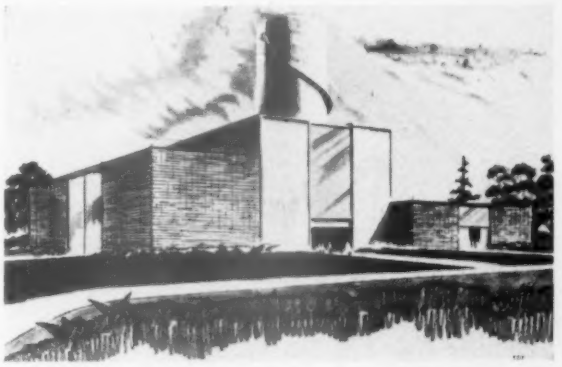


Diagram of the J.P.L. space environment simulator.



An architect's drawing of the Space Simulator Laboratory which is under construction at the California Institute of Technology's Jet Propulsion Laboratory in Pasadena, California. The tower-like structure is the upper part of the space simulator where the lighting system is housed; below is a large vacuum chamber where spacecraft will be tested for their reactions to the environment of space.

"What must be done," Mr. Howard says, "is to design a spacecraft which has the right colour, finish, material and shape to absorb just enough heat to maintain a warm temperature throughout. This is the main purpose of the space simulator which must be large enough to house the complete spacecraft in its flight configuration."

Optical System

Such a simulator must meet three basic requirements. It must have a lighting system which duplicates all the visible and invisible rays of the Sun in a collimated beam. It has to provide as near perfect a vacuum as it is practicable to accomplish in a chamber of this size. Finally, it must be designed in such a way that the inner walls do not emit heat, but absorb heat and light radiated by the spacecraft.

A unique feature of the space chamber is the optical system designed by Bausch and Lomb of Rochester, New York. Artificial sunlight is generated by 150 compact arc mercury xenon lamps, each one utilizing 2½ kW. of power and having a 16-in. reflector. The battery of lamps is fitted in a space on top of the chamber, permitting the direction of light downwards into the vacuum chamber through a 3-ft. lens.

The system is shown in the diagram. The light from the mercury xenon lamps, shining down on to a parabolic mirror, is reflected upward in a concentrated beam to a hyperbolic mirror. Once inside the chamber, the 3 ft. beam of light has to be widened to 15 ft. To accomplish this, a special 2½ ft. diameter mirror reflects the light beam to a parabolic mirror at the top of the cylindrical chamber. From there it shines down on the spacecraft in a collimated beam, as would actual sunlight in space. Eventually, it is intended to modify the system to project a 25 ft. beam.

One of the interesting features of this lighting arrangement is that it can be varied to simulate the intensity of sunlight that a spacecraft might be expected to encounter as near the Sun as Venus or as far away as Mars. Within this zone of operation, a great deal of radiant heat is intercepted by a vehicle travelling in space.

If it is well designed, the spacecraft will absorb some of this heat to keep its thermal balance near the optimum level. The remainder will be reflected back into space.

The big problem involved in re-creating these conditions on Earth is that when a spacecraft is confined in an ordinary vacuum chamber, the radiant heat is reflected back into the chamber by the walls, thus introducing false conditions.

In order to minimize these effects, an aluminium shroud is being provided inside the pressure chamber of the J.P.L. simulator. This is made of 200 plates which are dull black to absorb heat and cooled to −310°F.; a temperature which is maintained by pumping liquid nitrogen through small tubes running through the shroud. With this system, some 99% of the heat radiated from the spacecraft is absorbed and carried

away. The nitrogen (which boils at −320°F.) is stored in a 28,000-gallon tank outside the building.

A three-stage "pump-down" system is used to create vacuum conditions within the test chamber. The first stage is accomplished by seven compressors which are normally employed to run J.P.L.'s 20-in. supersonic wind-tunnel. Then a "roughing" system, consisting of three vacuum blowers, removes all but a small fraction of the initial air. At that point, 10 oil diffusion pumps take over to produce a vacuum of 10^{-6} mm. of mercury, which is about one hundred millionth of the atmosphere at sea level. (The vacuum of space is one hundred million times less than this.)

These diffusion pumps work continuously during tests to remove any outgassing or evaporation from the chamber.

The spacecraft to be tested will be placed on a special support in the simulator with the aid of a handling trolley. Twelve portholes in the chamber are provided for external observation.

Reactions of the vehicle will be monitored continuously by engineers in the control room, who will pay particular attention to the spacecraft's transmitting and receiving equipment, guidance and control system, and the scientific payload. This will be accomplished by electrical circuits which connect to various parts of the vehicle and lead through the walls of the chamber into the control room.

At a later date, it is hoped to install a vibration unit which will simulate conditions which a space-vehicle will encounter during mid-course manœuvres or when the retro-rockets fire.

In the years ahead, this unique "space environment simulator"—and others that will be built in order to help perfect the design of manned space vehicles—will find increasing use in the U.S. space programme. The Jet Propulsion Laboratory is, of course, directing the unmanned lunar and planetary exploration programmes for the National Aeronautics and Space Administration.

A "Solar Sandwich"

NEW methods of generating electrical power in space vehicles are continually being investigated. The latest is a "solar sandwich" which has been designed by the General Atomic Division of General Dynamics to obtain energy from sunlight, not as a normal solar cell, but by a process which first converts the Sun's energy to heat and then to electricity.

The device consists of tiny thermo-electric elements placed between two wafer-thin metallic sheets. Mounted on panels which remain folded during rocket launching, they can be extended automatically in space or on receipt of a radio signal. The "solar sandwich" is expected markedly to reduce the weight and cost of solar cell systems.

More Effort for Saturn

AS part of the new drive in the United States to accelerate the development of large space boosters, NASA has invited four companies to submit detailed proposals on the design, development and production of the Saturn S-II stage. These are Aerojet-General Corporation; Douglas Aircraft Corporation; General Dynamics, Astronautics Division; and North American Aviation, Inc.

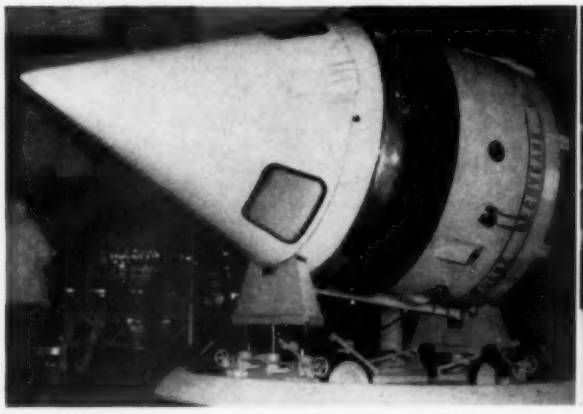
The S-II will form the second stage of the advanced Saturn which will have several times the payload capability of the Saturn C-1. It will be able to lift the three-man Apollo spacecraft to escape velocity and could be used for sending this vehicle on a circumlunar flight.

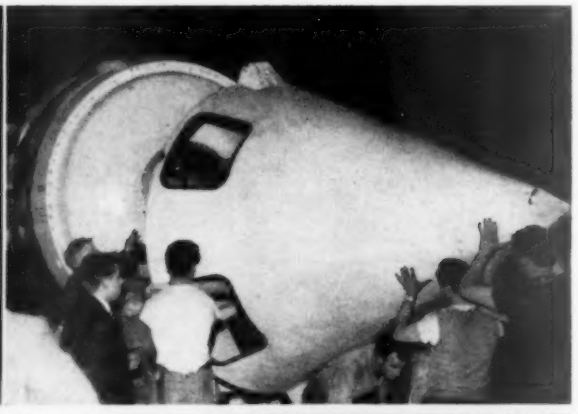
Powered by four J-2 liquid-hydrogen/liquid-oxygen engines already under development by the Rocketdyne Division of North American, the S-II stage will have a thrust of 800,000 lb. at altitude. First test firing of an advanced Saturn with a live S-II stage is expected late in 1964 or early 1965. A final contract should be signed by Oct. 1 this year.

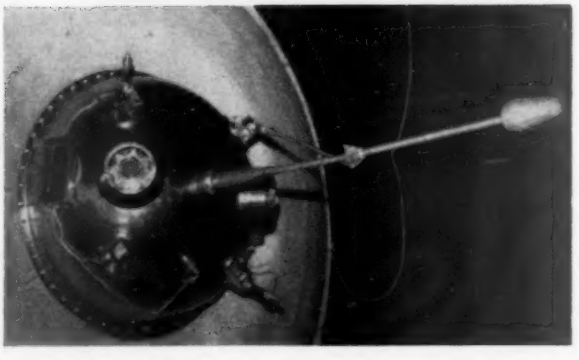
A Day in Orbit

AFTER the first few orbital missions of the Atlas-Mercury have been successfully completed, NASA is planning to extend the period spent in orbit up to 24 hours. Speaking in Los Angeles on Jne. 15, Mr. Walter Williams, operations director of Project Mercury, said that the first orbit attempts would be for three circuits.

"I would like to make it absolutely clear that I am not advocating sacrificial or suicidal missions," he said. "But I am saying that we must blend the man into the mission sooner—recognize that there are risks involved—and work on the basis of producing and flying a reliable man-machine combination."

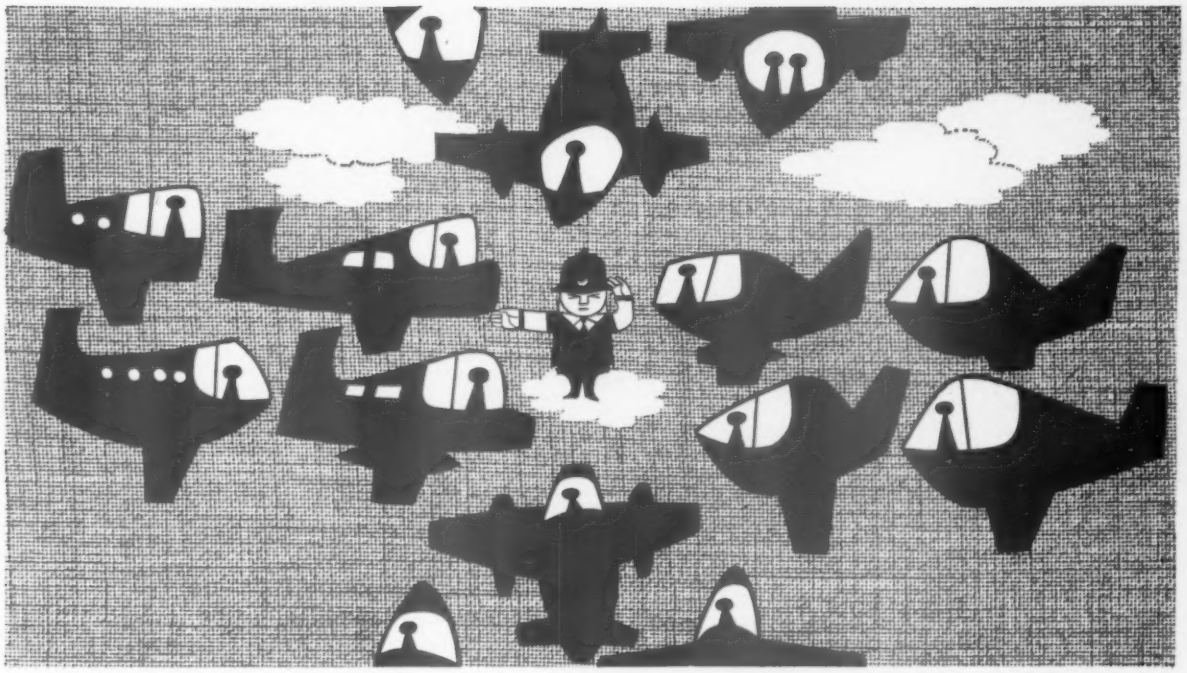






These photographs taken at the Soviet Trade and Industry Exhibition at Earls Court show a full-size replica of the last stage of the carrier rocket which launched Lunik II on a collision course with the Moon in September, 1959. Separation of the probe from the final stage occurred soon after the end of propulsion and both are assumed to have hit the Moon. Above, the complete top stage; above right, attachment of the nose cone; and right, close-up of the 858.4-lb. probe mounted in the rocket.

Photographs copyright "The Aeroplane and Astronautics"



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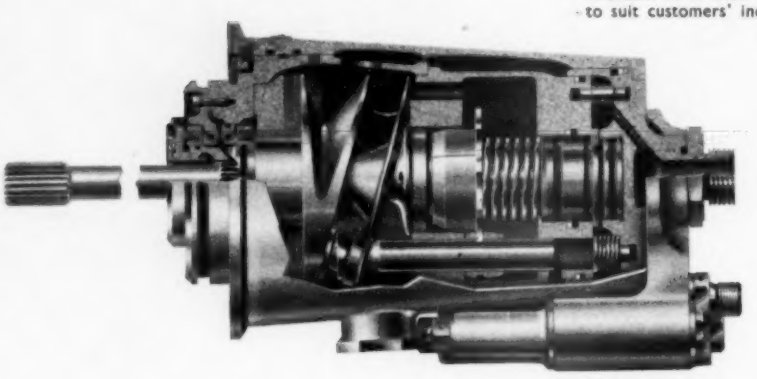

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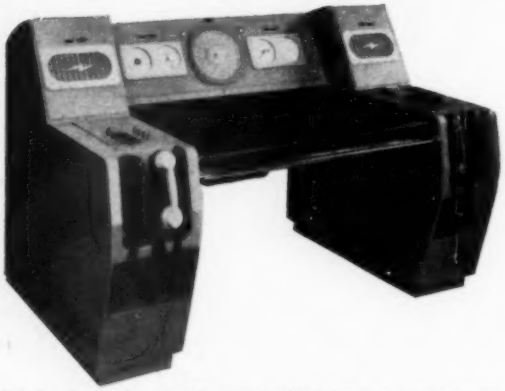

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The photographs show I.A.L. Control Consoles (above) for Aerodrome and Approach Control and (right) for a Communication Centre.

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Major Gagarin Meets the Press

FOR the technical journalist, there can seldom have been a more frustrating experience than the crowded Press conference which marked Major Gagarin's visit to the Soviet Trade and Industry Exhibition at Earls Court on Jly. 11. The genial astronaut faced five television cameras, 10 microphones, and more than 300 representatives of the World's Press, yet after a whole hour of questioning, not one new fact concerning technical aspects of the flight emerged.

This was no fault of Major Gagarin. Hardly any questions managed to get asked on a technical level and those that were had been answered on previous occasions.

Despite Major Gagarin's introductory remarks that so much had been published about his orbital flight that it was difficult to provide any new information, there is in fact much that remains obscure. So far, for example, the World has seen only four aspects of the event in pictures. These are: (1) The astronaut clad in his pressure suit before the flight, and preparing to enter a lift, presumably on the servicing gantry, which conveyed him to the Vostok spacecraft; (2) take-off of the rocket itself—an exceptionally "murky" picture on which only the grain in the film appears to be authentic; the rocket is heavily retouched and partly shrouded in cloud, obscuring all detail; (3) the astronaut resting after the flight; and (4) an internal view of the Vostok cabin showing certain controls and instruments.

At the time of writing, no external photographs of the Vostok have been released (unless one counts those of the vehicle displayed beneath a Mi-6 helicopter at Tushino on Jly. 9), nor have we seen the arrangement of the ejector couch or any other items of the internal and external equipment.

In contrast, Cdr. Shepard's Mercury capsule is detailed almost down to the last nut, bolt and welded seam. It was even put on display at the Paris Air Show in May for close public inspection.

If the Tushino airborne exhibit does represent the Vostok, it differs from Mercury in several important respects. First, and most obvious, is the fin-supported tail-annulus which gives the vehicle the appearance of an old-fashioned bomb. It would certainly have to be extremely robust to prevent being burnt off under re-entry conditions. The other essential point is that, unless the vehicle is mounted in an inverted position in the nose-cone of the launching rocket (and covered with a fairing), it would not appear to be designed to turn through large angles for re-entry (as does the Mercury capsule to face its heat-shield forward) so that some more complex arrangement would seem to be needed for accommodating the pilot.

The question is, therefore, does the Vostok's ejector couch turn through 180° between take-off and re-entry to permit acceleration pressures to be taken, in each case, chest to back? A Moscow correspondent, quoting a Soviet scientist on the day of the flight, in fact described the pilot as being placed "within a capsule which rotates through 360° within the ship to assume an optimum attitude under all conditions of flight."

Major Yuri Gagarin displays the Gold Medal awarded to him by the British Interplanetary Society "for distinguished services to astronautics."

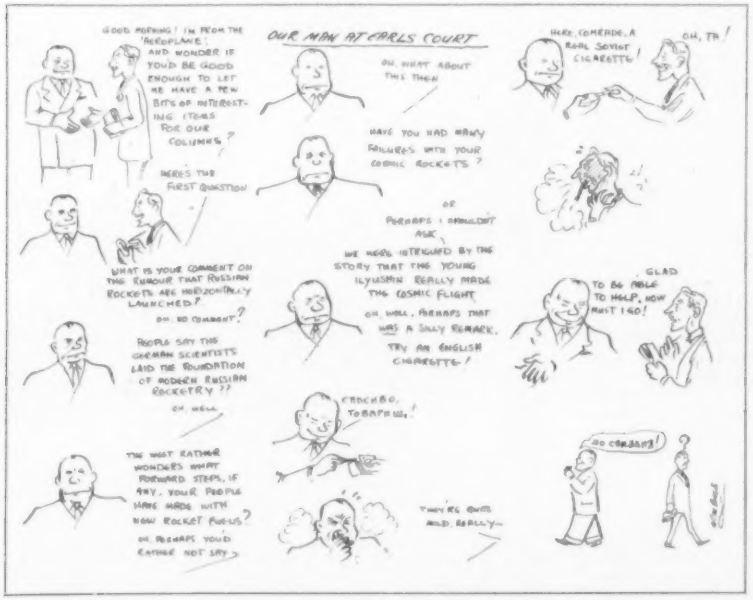
Yet no mention of how the ejector couch is accommodated within the Vostok appears in the official account.

There is, moreover, no official mention of the manner in which the Vostok was landed, nor is there any word on aerodynamic stabilizers. Although it seems fairly obvious that parachutes *were* used, this—to our knowledge—has never been specifically stated.

Even when submitting evidence of the Vostok's flight to the Fédération Aéronautique Internationale for official ratification in May, the Soviet authorities were careful to give the thrust rating of the rocket booster in obscure terms, leaving in doubt all features of the launcher except that it "had six engines at the moment of launching with a total thrust of 20 million h.p."

What Major Gagarin did say at the Press conference—when answering the question: "Would you like to see forthcoming launchings televised before the World?"—was that his own flight, including the initial stages of launching, had been photographed in colour and the film was now available. However, he did not say when this film would be publicly released and no one who had the eye of Mr. Soldatov, the Soviet Ambassador (who acted as chairman of the Press conference), seemed concerned to inquire.

Apart from a hint that another manned launching would soon take place, and that Major Gagarin himself was concerned with the planning of future operations, that was all. Questions about women in space and space fiction—yes! But none designed to clear up some of the mysteries which still surround the Vostok. It was a great pity that so few of the technically interested managed to get a hearing.—K.W.G.


OUR MAN AT EARLS COURT
GOOD MORNING! I'M FROM THE 'AEROPLANE'. AND WONDER IF YOU'D BE GOOD ENOUGH TO LET ME HAVE A FEW BITS OF INTERESTING ITEMS FOR OUR COLUMNS?
HERE'S THE FIRST QUESTION
WHAT IS YOUR COMMENT ON THE RUMOUR THAT RUSSIAN ROCKETS ARE HORIZONTALLY LAUNCHED?
OH, NO COMMENT?
PEOPLE SAY THE GERMAN SCIENTISTS LAID THE FOUNDATION OF MODERN RUSSIAN ROCKETRY??
OH, WELL
THE MOST FATHER WONDERS WHAT FORWARD STEPS, IF ANY, YOUR PEOPLE HAVE MADE WITH NEW ROCKET FUELS?
OR PERHAPS YOU'D RATHER NOT SAY
OH, WHAT ABOUT THIS THEN
HAVE YOU HAD MANY FAILURES WITH YOUR COSMIC ROCKETS?
OR PERHAPS I SHOULDN'T ASK
WE WERE INTRIGUED BY THE STORY THAT THE YOUNG ILYUSHIN REALLY MADE THE COSMIC FLIGHT
OH, WELL, PERHAPS THAT WAS A SILLY REMARK.
TRY AN ENGLISH CIGARETTE!
CRUCHEV, TOBAPIIIu.!
THEY'RE QUITE MILD, REALLY—
HERE, COMRADE, A REAL SOVIET CIGARETTE!
OH, TH!
GLAD TO BE ABLE TO HELP, NOW MUST I GO!
NO COMMENT!

Testing the F-1

A COMPLETE F-1 rocket engine—the largest in the Western World—is now undergoing a series of static firings, NASA announced on Jly. 11. The firings are the first to be made of a complete, self-cooled, F-1 as it would operate in a booster.

Many static tests of individual components have, of course, taken place during the two and a half years in which the huge single-chamber engine has been under development. Now the stage has been reached, according to officials, when the total system can be gradually built up to its rated thrust of 1.5m. lb. and a firing duration of 2.5 min. A thrust of about 1,000,000 lb. was obtained in the first firing.

The F-1, which is fuelled with liquid oxygen and kerosene, is being developed for NASA by North American Rocketdyne. Two of the engines are scheduled for use in the first stage of the Saturn C-3, intended to launch the Apollo circumlunar spacecraft, and it is also being considered for clustering in the huge Nova booster which will represent NASA's first attempt, "by the end of the decade," to land men on the Moon.

Flying the Beech Travel Air

No. 101 *in the series by John Fricker*

TWO flights were made in Short Bros.' Travel Air demonstrator, G-AREJ, for the handling assessment to be completed for this article. Although separated by several months, the first, at the company's Belfast base, and the second at Baginton during the Shackleton week-end, were both undertaken in really foul weather, which minimized a certain amount of the pleasure offered by this luxurious light twin.

As it was, only the fact that the Travel Air is perhaps the nicest among the aircraft of its class to fly redeemed the situation. On the first occasion, in fact, when there was a 35-knot gale blowing across the runway, accompanied by torrential rain from a 500-ft. cloud base, it was the tractability of this Beechcraft rather than any effort of its pilot that got it round a half-blind circuit over the storm-tossed Lough and through the gusty chimneys of Belfast back on to the ground in a memorable initial introduction.

At Baginton, more recently, conditions were different, but still unpleasant. Lowering evening light combined with mist and Midland murk, plus a low overcast, to reduce visibility to little more than 1,000 yd., and ceiling to about 1,000 ft. A certain amount of "actual" instrument time resulted, together with a positioning talkdown from the helpful Baginton radar. In the still air, however, the sweetness of Travel Air control could be savoured to the full.

This four/five-seater is much more of a twin-Bonanza than the rather bigger types which bear this appellation in the Beechcraft range. The Travel Air is derived directly from the Bonanza, with a similar fuselage and accommodation. It is fitted with two 180-b.h.p. Lycoming O-360 flat-four engines on extended wings, and the Vee tail of the Bonanza is replaced by a conventional empennage similar to that of the Beech Mentor trainer.

The Travel Air owes some of its above-average structural integrity to the aerobatic Mentor, as well as its very robust undercarriage, with its 10 ft./sec. deck-landing factors. At normal cruising speed of 170 knots, which is remarkably fast for its power, the Travel Air can survive loads of more than +6 and −4 *g*, which are well above corresponding factors for other U.S. lightplanes.

It was this reserve of strength which enabled S.F.E.R.M.A. to install Astazous of more than twice the power of the original Lycomings in the Travel Air, to produce the turboprop Marquis with very little structural modification. In effect, the same basic airframe is now available with the 180-b.h.p. Lycomings (fuel-injected IO-360-B1As in the current Model 95A Travel Air); 260-b.h.p. Continental IO-470-Ls as the Model 55 Baron; and 470-e.h.p. Astazous in the Marquis.

Since its introduction in 1956, the Travel Air has undergone rather more than average refinement. The 1960 model had a 19-in. cabin extension to provide room for an optional fifth seat, plus a similar increase in tailplane span to cope with the aft C.G. movement. Some aerodynamic improvements were also introduced.

The 1961 B95A Travel Air became a full five-seater with an increase in gross weight to 4,200 lb., which put up its useful load by nearly 200 lb. to a total of 1,645 lb. Larger rear windows were also introduced for back-seat visibility, together with other styling modifications and increased flap effectiveness. All these improvements were accompanied by a decrease in price of $2,000, so that at a U.K. delivered and duty paid cost of £22,120, the Travel Air is in a class of its own. U.S. cost, ex-factory, is $49,500.

Like all the Beech types, the Travel Air showed a standard of finish that defied even the direst attempts of the elements to make seem drab. The all-metal stressed-skin has a most attractive covering of heat-treated enamel, and the interior furnishings are to the same very high standards. To cope with the additional

Photographs copyright "The Aeroplane and Astronautics"

Points of interest in the commodious Travel Air cockpit include the throw-over control wheel and the leather-padded "eyebrow" coaming over the front panel.

instruments accompanying twin-engine operation, the front panel has been deepened compared with the Bonanza, but in the latest Travel Air, the front seats have been raised slightly to improve the view over the nose.

Instrument and control layout is fairly conventional, except for the omission of the now-standard central radio installation. G-AREJ, with about 170 lb. of radio, has its ADF, VHF, ILS and VOR control boxes grouped below the full flight panel on the port side, probably because the high location of the central console, with its forest of long pitch, throttle and mixture levers, would otherwise interfere with their operation. I was prepared to accept this, although it is less than an ideal arrangement, but I definitely disliked the juxtaposition of the throttle and pitch levers from their usual positions so that the power controls were in the centre between airscrew and mixture handles.

Good features, on the other hand, were the individual trim wheels for all three controls, distinctively light-coloured against the dark console, mounted in their logical planes and with adjacent window indicators for position. Full marks to Beech. This company is unique among its national competitors in using a centre-mounted control-wheel shaft in its smaller aeroplanes, with a throw-over facility for either front seat.

On each side the shaft can be locked in two positions to give either a high or a low control wheel setting. In the perverse nature of things, I felt that an intermediate position would have been ideal, but in the end settled for the high setting. On the long flights of which the Travel Air is capable, it might be restful to vary the position between its two settings, particularly because, in addition to the fixed arm rests on the upholstered cabin walls, there is a big central rest which may be raised on a pedestal between the seats.

The rectangular control wheel of the earlier Travel Airs has been replaced in the B95A by a ram's-horn type. The original version in G-AREJ proved quite comfortable, and was augmented by a Tactair T-3 autopilot with its control box on the centre console. This was not tried in flight, but I commend its installation, as such pilot aids are virtually essential even to the lightest touring aircraft using radio navigation under European conditions.

With Short Bros.' pilot John Formby in the right-hand seat on each occasion when I flew the Travel Air, engine starting was very simple under his supervision. Noise and vibration level were both remarkably low. Fuel capacity is either 84 or 112 U.S. gal. of usable fuel, in a 25-gal. inner-wing main tank on each side, plus a 17- or 31-gal. auxiliary tank outboard of each nacelle.

In G-AREJ, tank capacities were marked in Imp. gal. as 21 inner and 26 outer per side (94 in all).

The nosewheel steers through 17° each side of centre from the rudder pedals, and use of the potent toe brakes increases this to 29°. Ground manœuvrability is therefore excellent: the long-stroke undercarriage gives a well-cushioned ride for real grass-field capability, and the Travel Air could not be more stable when taxi-ing, taking-off or landing.

Short-field Take-off

Despite the very strong cross-wind for my first take-off at Queens Island, I found no difficulty at all in keeping straight during the brief ground run. With aileron and rudder trims neutral, and slight nose-up bias on the elevator according to the slightly difficult-to-see indicator, the Travel Air accelerated briskly at full throttle and 2,700 r.p.m.

V_{mc} is 80 m.p.h., so that rotation at 70 m.p.h. and an unstick at 85 results in a take-off which is both safe and short-field. The minimum control speed, of course, is below that at which the aircraft will climb on one engine, but the transition to V_2, or the minimum take-off safety speed of 96.5 m.p.h. (blue-lined on the A.S.I.), is very rapid.

Acceleration is aided by the speed of undercarriage retraction, which is only about four seconds, and also by the fact that when the gear is extended the fairing doors close to preserve the low-drag contours and keep mud out of the wheel wells. Although the normal undercarriage extension speed is 150 m.p.h., itself commendably high, the gear may be lowered at up to 200 m.p.h. in an emergency to act as an air brake.

Trim changes on retraction are small. Power can be reduced to 25 in. Hg and 2,450 r.p.m. for the climb, which is uncomfortably steep at the best rate speed of 103 m.p.h., and still vigorous at the cruise-climb figure of 140 m.p.h. At our intermediate weight, the Travel Air indicated around 1,500 ft./min. during an initial low-speed climb-out, and even at the new gross weight of 4,200 lb., it can still ascend at over 1,250 ft./min.

Acceleration on such relatively low power is extraordinary. Throttling back to around 23 in. Hg and 2,300 r.p.m., which gives about 65% power, and closing the electrically-operated cowl flaps, the Travel Air quickly settled down to indicate about 170 m.p.h. at about 1,500 ft. The same setting at rated altitude of about 8,000 ft. gives a T.A.S. of 195 m.p.h. for a consumption of only 7½ Imp. gal. or so per hr. for each engine. Carrying five people and some baggage at this sort of speed while returning a consumption of about 13 a.m.p.g. takes some beating—especially as the operating range, including full allowances, is almost 1,000 miles.

A stimulating single-engine performance is displayed by the Travel Air, which has feathering Hartzell propellers for its 180-b.h.p. Lycoming engines.

From the control point of view, the Travel Air conforms to the same high standards. Forces are moderate and progressive, allied to positive stability and good harmonization. Lateral response is particularly effective, having servo assistance. The lack of effort needed to fly the Travel Air, coupled with its high standard of comfort and low noise level must make it one of the least fatiguing of any of the American light twins for long-range operation. In and out of odd patches of cloud, it was very simple to fly on instruments.

Despite the low ceiling and poor visibility experienced during my second, and more prolonged, flight in the Travel Air, its tractability was such that I felt little hesitation in exploring fairly thoroughly the low-speed corners of its flight envelope. Power off, in the clean configuration, speed falls off slowly as the nose is held level. Unlike many clean modern aircraft, the Travel Air has some airframe buffet before the stall breakaway, as a useful additional warning to the artificial aural and visual indication about 4-6 m.p.h. above the point where it quits flying. This appeared to be around 75 m.p.h. I.A.S., followed by a straight nose drop.

Lowering the single-slotted flaps below their limit speed of 130 m.p.h. causes a very small nose-up trim change. Like the undercarriage, the flaps are electrically actuated, with a maximum deflection of 33°. When stowed, they extend aft of the wing trailing-edge, and are infinitely variable in extension via the cockpit switch. Green and red lights on the port panel mark the stowed and fully extended positions, with intermediate settings indicated by lines on the port flap.

With flaps and undercarriage down, I found that all three controls remained effective, in varying degrees, as power and speed were progressively reduced. At less than 60 m.p.h. I.A.S., the Travel Air was still flying, and with demonstrable, if sloppy, lateral control, just before a more pronounced buffet and artificial stall warning became evident. The breakaway, when it eventually came, was around 53 m.p.h. I.A.S.; it took a great deal of effort to achieve, and was accompanied by a mild starboard wing drop.

Cleaned up again, the Travel Air was brought back to cruising power before trying some asymmetric flight. The swing, on bringing back the throttle, pitch and mixture levers on one engine, was held with very little difficulty until the airscrew feathered, when a couple of thumbfuls of rudder trim brought the ball of the turn and slip back to centre. With full power on the live engine, raising the nose to the single-motor climb speed of 103 m.p.h. brought the V.S.I. to an indicated 300 ft./min. ascent, and turns in either direction presented no difficulty.

With both Lycomings back in business, Baginton radar brought us back into the congested circuit, through which the Travel Air weaved, in the landing configuration, like a sports car. As instructed, we used the short grass strip alongside the runway, bringing G-AREJ round at about 110 m.p.h., and reducing to about 90 for the final approach. With a trickle of power to regulate the sink, this gave a pleasantly steep glide path and a leisurely flare-out for a minimum speed (75 m.p.h.) touch-down.

With no further effort, the landing roll was very definitely

Short's Travel Air demonstrator shows its distinctive plan view, with swept-forward inner leading-edges, and projecting flaps.

short-field, with a pronounced deceleration. I was most impressed, particularly when opening up again to taxi in I discovered from the amount of power I had to use that I had inadvertently left a certain amount of brake applied through unfamiliarity with the parking catch release. This is how to make really short-field landings when you have an aeroplane as uncomplaining as the Travel Air.

All the American light twins, without exception, are nice aeroplanes, but I liked the little Beech especially for its combination of high performance on low power, with extreme ease of handling and docility. This would seem to make it a natural choice for the fly-yourself executive who wants a near 200 m.p.h. cruising speed with exceptional economy.

Leading Particulars

Dimensions.—Span, 37 ft. 10 in.; 25 ft. 2 in.; height, 9 ft. 6 in.; wing area, 199.2 sq. ft.; undercarriage track, 9 ft. 7 in.; wheelbase, 11 ft. 4 in.

Weights.—Empty, 2,635 lb.; useful load, 1,465 lb.; payload, for occupants and baggage, full tanks (70 Imp. gal.), 948 lb.; useful load (B95A), 1,645 lb.; payload, full tanks (B95A), 1,148 lb.; gross weight, 4,100 lb. (B95A, 4,200 lb.).

Performance.—Max. cruise, 75% power, 7,500 ft., 200 m.p.h.; 65% power, 10,500 ft., 195 m.p.h.; initial climb, 1,300 ft./min.; single-engine climb, 191 ft./min.; service ceiling, 18,700 ft.; single-engine ceiling, 5,050 ft.; stalling speed, all-down, 70 m.p.h.; take-off run, 20° flap, 1,000 ft.; to 50 ft., 1,280 ft.; landing run, 28° flap, 980 ft.; from 50 ft., 1,590 ft.; range, at 45% power, 1,056 miles; with aux. fuel, 1,410 miles at 165 m.p.h.; endurance, 8.75 hr.

Gliding Notes

by Dr. A. E. Slater

REMARKABLE photographs of cloud patterns over the oceans, taken and then broadcast from the Tiros I weather satellite, are published and analysed in *Tellus*, Vol. 13, No. 1. The clouds are at low level, and as the sea was known to be warmer than the air on each occasion, they show the pattern of upcurrents arising from sea level.

The weather in each case was anticyclonic in the area of the photographs, one of which was taken over the Atlantic and two over the Pacific. In the Atlantic region, ships reported the sea surface to be about 3° C. warmer than the air just above it. Over land this difference would be quite enough to produce fairly strong thermals.

Cloud base was about 2,000 to 3,000 ft. and the tops were at 4,000 ft. in the northern part and 12,000 ft. in the southern part of the region photographed. But what of the gaps between upcurrents?

* * *

Here we come upon some rather awkward features of the cloud pattern. Gliding people first heard about the regularity of "convection cell" patterns in 1933 when Sir Gilbert Walker lectured to them on model experiments done under his direction at Imperial College. Smoke was blown into a shallow wind channel 6 in. wide and 0.3 in. deep, with a steel bottom electrically heated, and a glass top through which the pattern of the resulting upcurrents could be watched.

The pattern was one of "cells," each cell having an upcurrent in the middle and downcurrents round its edges, like the cells into which strato-cumulus and alto-cumulus cloud sheets are so characteristically subdivided. And by sliding the glass top to produce "wind shear," a pattern of parallel "cloud streets" resulted.

Later, Sir Gilbert's successor, Sir David Brunt, produced similar cells in liquids, particularly cheap gold paint in a watch glass, which produces imitation strato-cumulus on a still smaller scale. But almost invariably the upcurrent was in the centre of the cell, and each cell was about 2½ times as wide as it was high; so that a sailplane with a gliding angle better than 1 in 2½ should have no difficulty in getting around among scaled-up versions of similar cells. In fact, the spacing of cumulus clouds is often not far different from 2½ times the depth of the convection layer from ground to cloud-top.

But when one examines the pattern of convection cells over the ocean, as revealed by satellite photographs, quite a few snags appear. The most obvious feature is that the "cells" are upside down; each consists of a ring, or partial ring, of clouds enclosing a clear area where presumably the down current reigns.

Another feature is the great width of the cells compared with their height. In the Atlantic photograph they are 30 times as wide as they are high, and the diameters of the more well-marked rings are about 1 degree of latitude, or 60 nautical miles.

This means, first, that a glider pilot would have to work his way round the ring instead of trying to glide across it; and secondly, that the pattern is on too large a scale to be seen clearly from low down, so it would be difficult to plan the next move. The cloud pattern probably undergoes continual change, and one would need to receive, by television, continuous photos from relays of satellites, or from a satellite in a 24-hour orbit, permanently perched 22,000 miles overhead—and to be able to locate one's position on the photograph.

Even in one of the Pacific photos, when there was a 30-35-knot wind at sea level, the clouds were still arranged in rings, not streets. But, as in streets, the lines of clouds were subdivided into distinct confluent lumps.

One thing to remember is that the sea hardly changes its temperature between day and night, so the upcurrent pattern should last as long as the anticyclone.

Sir Hiram Maxim, in his book "Artificial and Natural Flight," published in 1908, writes on p. 16 of an Atlantic voyage during which he passed through a convection cell marked by a succession of parallel lines of calm water with the winds alternately converging towards, and diverging from, the areas of calm. But the pattern must have been one of "streets," as the calm belts stretched straight to the horizon both ways.

* * *

SINCE 1950, when Gold "C" pilots could add Diamonds to their badge for 500 km. distance, 300 km. goal flight, and 5,000 m. height gain, the number of pilots with all three diamonds has grown to 164, according to the latest international list which includes last year's crop. Poland, with 56, and France, with 53, are still running neck-and-neck—or should one refer to canopies, now that high wings perched on "necks" are out of fashion? The United States, whose John Robinson is No. 1, now has 16, Germany 13, and Yugoslavia and Czechoslovakia 6 each.

Great Britain's three, so far confirmed, are Nicholas Goodhart, No. 42; Tony Goodhart, No. 141; and Philip Wills, No. 149. This year's "three Diamonds" will include Mr. and Mrs. Burns, but Ann Welch has, I believe, still to get her height Diamond. It would be interesting to know how many of the heights have been done in cumulo-nimbus clouds and how many in waves. People seem to prefer their native cu-nims, but many go elsewhere, especially to France, for their waves.

Correspondence

Claims on the Schneider Trophy

WITH reference to the letter in THE AEROPLANE AND ASTRONAUTICS for Jly. 6, in connection with the Schneider Trophy.

I do not know the conditions as to the final resting place of this Trophy, now held at the Royal Aero Club, but I feel that the Air Ministry have a justifiable claim for it to be placed in the Air Ministry, Whitehall Gardens. After the Trophy was won outright for Great Britain in 1931, by Flt. Lt. J. H. Boothman, Royal Air Force, it was for some time on display in the R.A.F. Club. For many years now it has almost been hidden away in a rather inconspicuous position in the Royal Aero Club.

I think also that the R.A.F. Club might like to have it back where, if it were placed in the vestibule hall of the club, it could be displayed to much better advantage than at present, and also be of much more interest especially to young Service officers.

London, S.W.3. W. A. RAMSAY.

Squadron Facts

IN THE AEROPLANE AND ASTRONAUTICS dated Jne. 29, 1961, in the item on page 740 headed "A City Honour for the R.A.F.", it is stated regarding No. 216 Squadron R.N.A.S. that on the formation of the Royal Air Force (it) was renumbered 216 and equipped with D.H.10s. To the best of my recollection this is not correct. I was at Dunkirk and was a pilot in 217 Squadron from a few days after the formation of the R.A.F. until a couple of weeks before the Armistice when 21 out of 23 officers in this squadron went down with 'flu. During this time we were well aware of the H.P. O/400s flown by 216 but never did I see or hear of a D.H.10 being flown in the Dunkirk area. In fact, I believe I am right in saying that the D.H.10. never became operational, certainly not during hostilities.

217 Squadron was equipped with D.H.4s (Rolls-Royce Eagle VIII) and regularly flew on patrols over the sea at low altitudes; for this work it was always understood that their equipment should have been D.H.10s, but that these were not available. Incidentally, such was the reliability of the Rolls-Royce engines that, as far as I can remember, only one aircraft and crew were lost at sea owing to engine failure.

I feel sure that present members of 216 Squadron would wish that statements regarding their earlier equipment should be as factually correct as possible.

Harpenden. F. E. BRIDGES.

[Our correspondent's memory may well serve him correctly regarding the operational use of D.H.10s by No. 216 Squadron in France before the Armistice. The records show, however, that the Squadron was subsequently equipped with these aircraft and used them in Egypt.—ED.]

Sunderland Highlights

AS a one-time member of the Short Bros. Seaplane Works at Rochester back in 1940-41, your report "Memorial at Pembroke" (page 361, Apr. 6) brought back to me quite a flood of nostalgic memories. Mr. Peter Thomas is certainly to be congratulated for his long campaign to save a Sunderland.

How well I remember the vivid impressions these great and beautiful flying-boats conveyed to me in the first few weeks of 1940 at the old Seaplane Works. It was certainly a thrilling sight to watch the boats being finally completed in No. 3 Shop (the biggest at the works in those days). Equally fascinating was to see them wheeled on beaching gear down the slipway into the placid waters of Medway River.

By 1940 the Mk. I Sunderlands had reached the stage where they were so urgently needed in Coastal Command that some were not even given a local test flight! Both R.A.F. and R.A.A.F. crews simply came to the factory and flew each boat away within a very short time of its launching. Of course, when the Battle of Britain was in full swing many hundreds of man-hours were lost in production; many a Luftwaffe bomb was aimed at Seaplane Works—but fortunately there were never any direct hits.

A few odd highlights in the Sunderland's 21 years of colourful history would be worth mentioning. The original Mk. I prototype (K.4774) made its first flight in October, 1937, with, of course, John Lankester Parker at the controls. By July, 1938, the first five Mk. Is had been delivered to No. 230 Squadron at Singapore. A grand total of 721 Sunderlands of all marks were built between 1937 and 1946, coming from factories at Rochester, Belfast, Lake Windermere, Dumbarton and Brough (Blackburn Aircraft built those at Dumbarton and Brough). There were 75 Mk. Is; 58 Mk. IIs; 407 Mk. IIIs; 31 Mk. IVs; and 150 Mk. Vs. The last Sunderland built, a Mk. IV, came from Blackburn's Dumbarton works (Serial No. PP.164).

Your brief report mentions the rescue of U.K. and Allied Service personnel from Crete and Greece. Well before these mass evacuations, two Sunderlands of Coastal Command participated in the dramatic rescue of the complete crew (34 men) of the torpedoed "Kensington Court," some 70 miles off Ireland, on Sept. 9, 1939. This was the first time Sunderlands took part in a grand rescue operation.

Nairobi. DENNIS M. POWELL.

Wroundabout

Vice Versa. Then there was the aviation company director who, asked what he would like to be when he retired, replied "An Air Vice-Marshal."

*

Though? "Mercury daytime flights, though flown by Rolls-Royce equipment, are operated at first-class fares." *Philippine Air Lines journal* "*The PALiner.*" Looks as though Pratt & Whitney have talked IATA into a "Rolls-Royce Differential."

*

Lightning Line

"The Mach Meter calibrations begin at 1."

*

At an airline's recent Staff Day, the most popular event was the selection of Miss Directed Luggage of 1961.

*

Off the Mach. An Indian paper reckons that that country should have fighters "capable of not less than March 2." To be delivered before August Bang Holiday.

*

There, but for modesty . . . Aviation writers on the North American continent are calling themselves "opinion-formers" and "communicators." As a cartooning columnist I come somewhere in between—a sort of form-communicator, with a well-formed opinion of North American aviation writers.

*

Replies to Readers

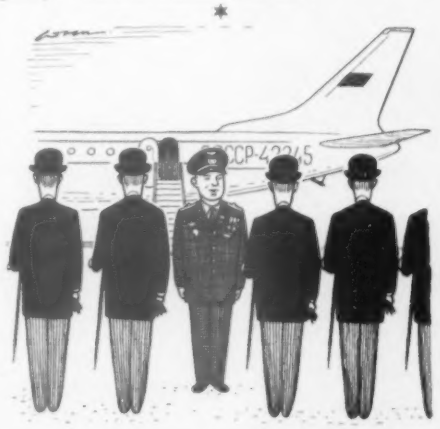
R.H., Washington D.C., U.S.A.: No, Wroundabout has not got a grudge against Boeing.

R.B., Weybridge, Surrey: No, Wroundabout is not subsidized by Boeing.

*

Wrongs wrighted. Some of last week's Wroundabout was dictated over the phone and I sympathize with the poor secretary who, mindful of this column's sparkling reputation, typed "speaking of wit" instead of "speaking of which" in the third item. Also, in Item 4, that extract from the Weights and Measures Bill should have read: "'Capacity measurement' means measurement in terms of measurement of capacity." Serious business, humour.

*



"Take me to your leader"

by Gren

Industry Record

Flexible Tubing Advancement

Under the name "Jetflex" the Power Flexible Tubing Co., Ltd., is to market a new type of flexible tube designed primarily for aeronautical application. This has recently completed a test programme under official A.I.D. surveillance and, says the company, is the first product of its kind to meet entirely the test requirements laid down in specification DTD.RDI.3955 drawn up in 1955.

It was with the development of the aircraft turbine engine that the need arose for flexible piping suitable for conveying fuel and lubricating oils, water, de-icing fluids, etc., at temperatures considerably higher—and, in some cases, somewhat lower—than had previously been the case. This led to stainless steel corrugated tubing becoming widely used.

However, although stainless steel has been used with satisfactory results, constantly advancing temperature and pressure requirements have accentuated the need for the development of high-grade heavy-duty components of this type. The widespread use and increasing importance of corrugated stainless steel flexible metallic tubing led to the issue of a design specification in 1955. This outlined the characteristics desirable for the stringent safety requirements for modern aircraft.

At that time no product approached the requirements laid down and since then considerable efforts have been made by manufacturers to develop a tubing that would in every way satisfy them. The specification outlines a wide range of test requirements which, in effect, subject the tubing to the most arduous simulated service conditions. Since its drafting in 1955 it has been continually reviewed and amended.

Until recently, it is claimed, no product has entirely met the test requirements—largely due to the new techniques required to manufacture flexible tube of an outstanding quality and to the complicated nature of the test rig equipment required to subject the tube to the necessary tests. With Jetflex, however, Power Flexible Tubing has successfully completed the range of tests laid down for one size of tube, namely, ½-in. nominal bore; other sizes which will eventually become available are at present under test.

Apart from the usual size, suction, elongation, proof pressure and flame checks, one of the most interesting test requirements involves an endurance-vibration-pressure-impulse test. Complete assemblies of tubing and fittings are subjected simultaneously to pulsating pressures, and both high vibration and temperature.

Internal pulsating pressure is applied to the tubing at a rate of between 12 and 24 cycles per min. and the full proving test is carried on for a total of a quarter of a million impulses. Each complete cycle starts at 10% of the design working pressure; this is followed by a rapid rise to full design pressure (within 20% of the cycle time), full pressure is then maintained for 10% of the cycle time, and finally there is a cut-back to 10% pressure. The maximum design pressure can be as high as 2,000 p.s.i.

Vibration is applied in two stages; at an amplitude of ±0.050 in. at 3,000 c.p.m. and at ±0.010 in. at 10,000 c.p.m.—every assembly being subjected to 125,000 pressure impulses at each stage. Assemblies are mounted for testing with a 90° bend at minimum bend radius and are reversed at each vibration stage. At the same time an ambient temperature of 400°C. is maintained around the tubing assembly and the flow of fluid (whilst under the impulse pressure test) is controlled to ensure an outlet temperature not exceeding 90°C.

The tubing is made from corrosion-resistant and weld-decay-proof titanium-stabilized stainless steel. Corrugations are annular and are formed with the minimum of metal stretching. External armouring is provided by stainless steel wire braiding. This has an improved form of weave devised to ensure constant strength and reduce elongation under pressure almost to the point of elimination.

A new range of compact lightweight end connections in stainless steel has been designed and their attachment to the tubing is by direct Argonarc welding.

Speeding the Turn-round

Now in use at Dublin Airport for any on-the-spot welding repairs necessary to the Boeing 720-048s of Irish International Airlines is a mobile self-contained electric welding unit. This has been manufactured by the British Oxygen Co., Ltd., to the airline's specification and was supplied by Industrial Gases (I.F.S.), Ltd., Eire, a B.O.C. associate.

Employing the Argonarc process developed by B.O.C., the unit has an AC transformer for welding aluminium and an AC/DC motor generator for welding copper and stainless steel. The AC set is connected to a DC suppressor and high-frequency unit to supply the water-cooled Mk. III and the air-cooled Mk. II torches. Similarly the AC/DC welding set can be connected to the same high-frequency unit and torches. The Mk. III torch has a self-contained water-cooler system, including a water tank and circulating pump.

Other equipment included on the unit is a low-voltage headlamp, a high-speed grinder and a hand cutting tool. Power comes from a 380-V., 3-phase and neutral cable connected to hangar or apron power points.

With a Boeing 720 of Irish International Airlines in the background, the mobile electric welding unit described alongside is about to be used on the servicing apron at Dublin Airport.

Aviation Calendar

Jly. 22

Lossiemouth.—R.N. Air Station At Home.

Jly. 23

Seething.—Waveney Flying Group At Home, at 10.15 hrs.

Jly. 24

Oslo.—AGARD Avionics Panel Meeting on "Microminiaturization"; until Jly. 26.

Oslo.—AGARD Structures and Materials Panel Specialists' Meeting; until Jly. 26.

Jly. 26

London.—Kronfeld Club lecture, "Gliding in Ghana," by G. A. Burgess, at 74 Eccleston Square, S.W.1.

Jly. 27

Oslo.—Eleventh AGARD General Assembly on "Scientific Goals of Space Exploration and Research"; until Jly. 28.

Kidlington.—International Business and Touring Aircraft Competition; until Jly. 29.

Company Notices

NEW COMPANIES

Air Cushion Development, Ltd. (697,037).—Private co. Reg. Jne. 30. Cap. £100 in £1 shrs. To carry on the business of manufacturers, inventors, developers, designers, builders, fitters, proprietors and letters on hire of, and agents for, hovercraft of all kinds; and waterborne craft, land and snow vehicles. Sec. Robert M. Gray. Reg. off.: 10 Bridge Street, Christchurch, Hants.

Business Flights, Ltd. (696,834).—Private co. Reg. Jne. 29. Cap. £100 in £1 shrs. To carry on the business of aeronautical experts and consultants and as owners, manufacturers, repairers and charterers of and dealers in aeroplanes. Directors: Norman C. Fisher, and Margaret Fisher, both of Broadwater House, North Chailey, Lewes. Sec.: S. O. Musgrove. Sols: Francis and Crookenden, 31 Great Queen Street, W.C.2. Reg. off.: 31 Great Queen Street, W.C.2.

W. H. and J. Rogers (Aviation), Ltd. (696,406).—Private co. Reg. Jne. 23. Cap. £100 in £1 shrs. To carry on the business of aeronautical engineers. Directors: Neville A. Rogers, Risinghoe, Castle Mill, Renhold, Bedford. Michael A. Rogers, Castle Mill, Renhold, Bedford. Sec.: N. A. Rogers. Reg. off.: The Firs, St. Neots Road, Great Barford.

Southampton Airport, Ltd. (696,574).—Private co. Reg. Jne. 26. Cap. £100 in £1 shrs. Directors: John N. Somers and Mrs. Phyllis Somers, both of 7 Cadogan House, 93 Sloane Street, S.W.1. Sec.: Mrs. P. Somers. Reg. off.: Eagle House, Jermyn Street, S.W.1.

West Wales Gliding Co., Ltd. (696,858).—Reg. Jne. 29, as a company limited by guarantee without share capital. The original number of members is ten, each being liable for £1 in the event of winding up. To promote, assist and encourage gliding, soaring and aerial navigation in all its forms in West Wales. The management is vested in an Executive Committee, including a representative of the B.G.A., Ltd., and Shaw Slingsby Gliding Trust, Ltd. Sec.: Arthur R. Squibbs. Sols.: Harveys, S.E.13. Reg. off.: Clarence Hotel, 1 Esplanade, Tenby, Pembrokeshire.

New Patents

APPLICATIONS ACCEPTED

875,703.—**ACF Industries, Inc.**—"Aircraft stabilizer trim force simulation." Apr. 10, 1959. (Apr. 15, 1958).

875,799.—**General Precision, Inc.**—"Grounded aircraft-training apparatus." Sept. 3, 1957. (Sept. 21, 1956).

875,800.—**General Precision, Inc.**—"Flight Simulation apparatus." Sept. 6, 1957. (Sept. 21, 1956).

Printed specifications of the above will be available on Aug. 23, 1961, and the opposition period will expire on Nov. 23, 1961.

Personal Notices

BIRTHS

Chappell.—On Jly. 6, at Holyhead, to Nancy, wife of the Rev. E. R. Chappell, R.A.F.,—a daughter.

de Garis.—On Jne. 26, at R.A.F. Hospital, Wegberg, to Tine, wife of Sqn. Ldr. L. de Garis—a son.

Williams.—On Jly. 5, at Bromley, to Diana, wife of Wg. Cdr. A. Talbot Williams—a son.

Penny.—On Jly. 3, to Ursula, wife of Flt. Lt. J. A. Penny—a daughter.

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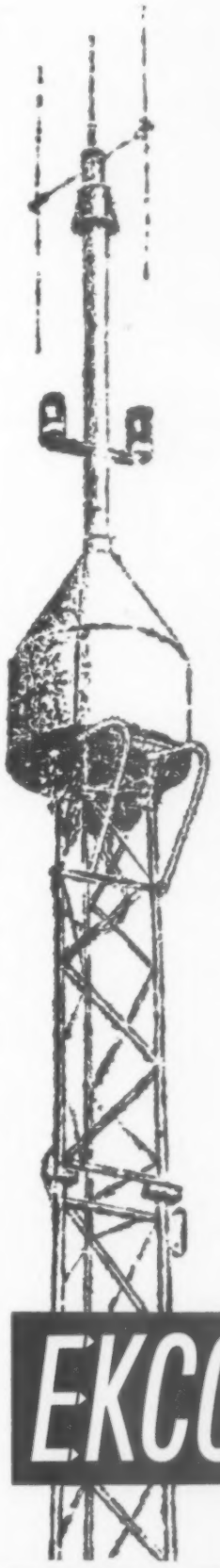

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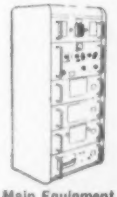

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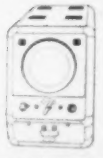

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